№ 1. Vol. 3. ONE SHILLING NET. July, 1903.

PAGE'S MAGAZINE

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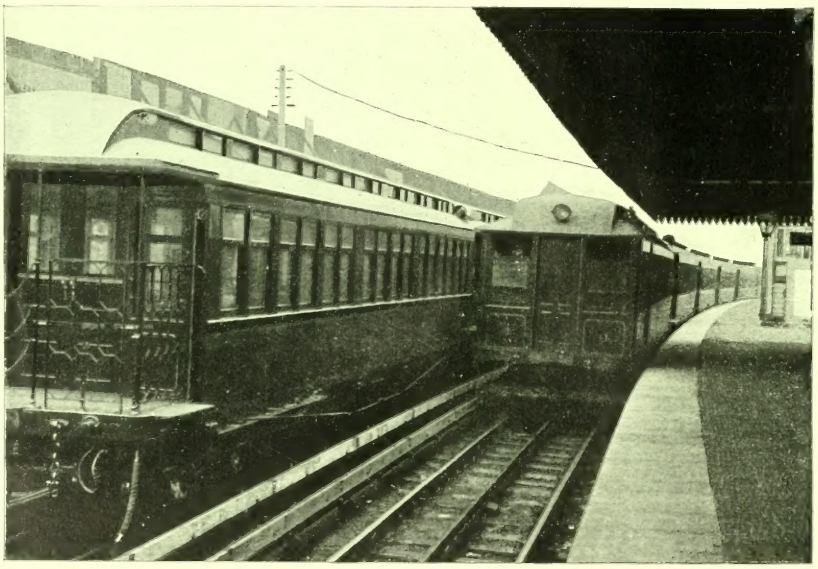

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(Continued on Page 4.)

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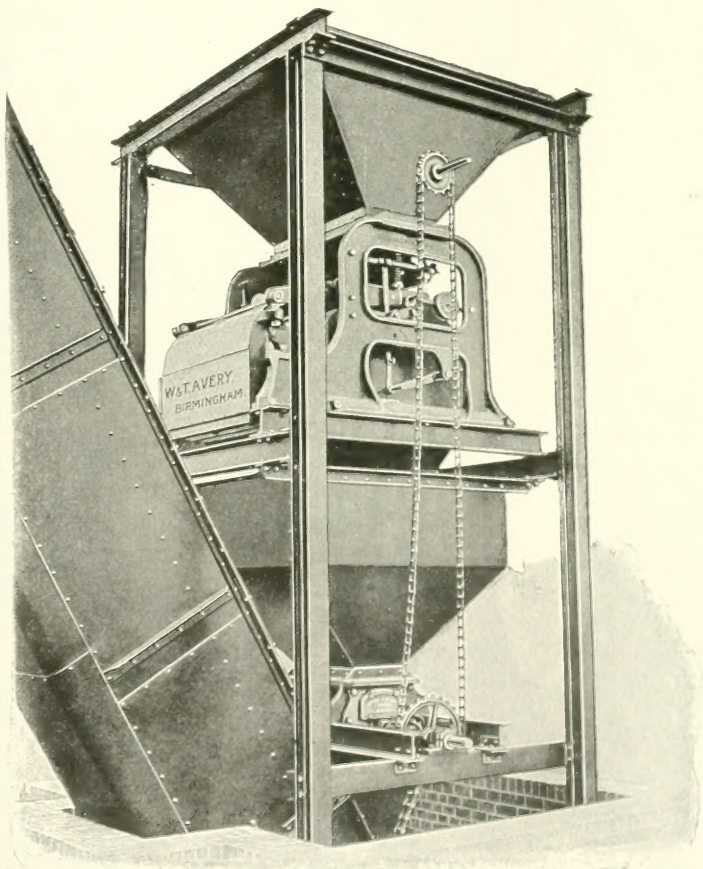

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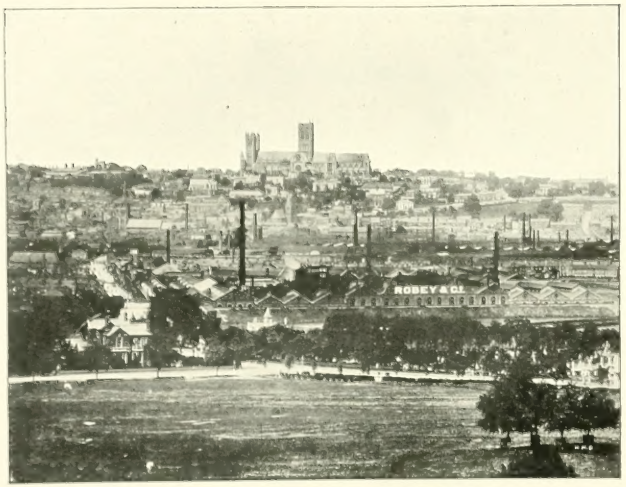

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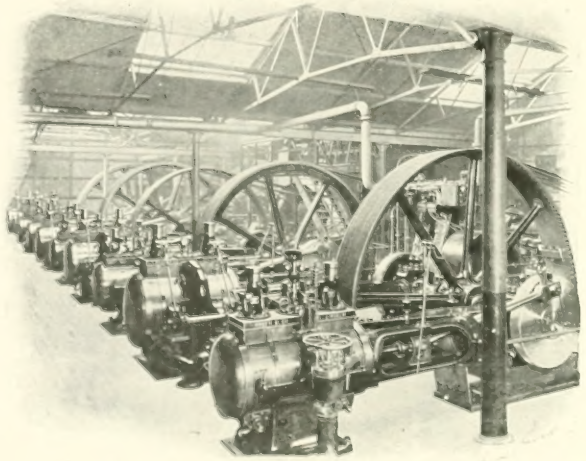
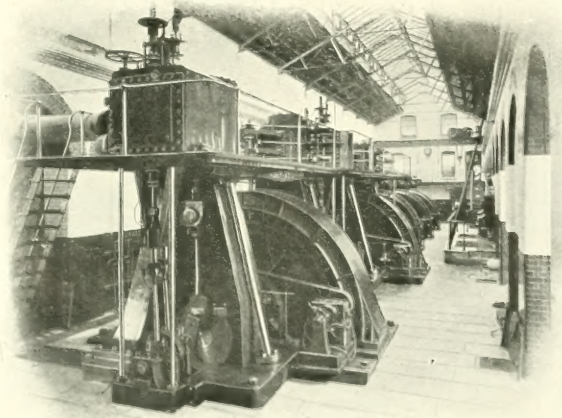


Coupled Compound Horizontal Fixed Engines.



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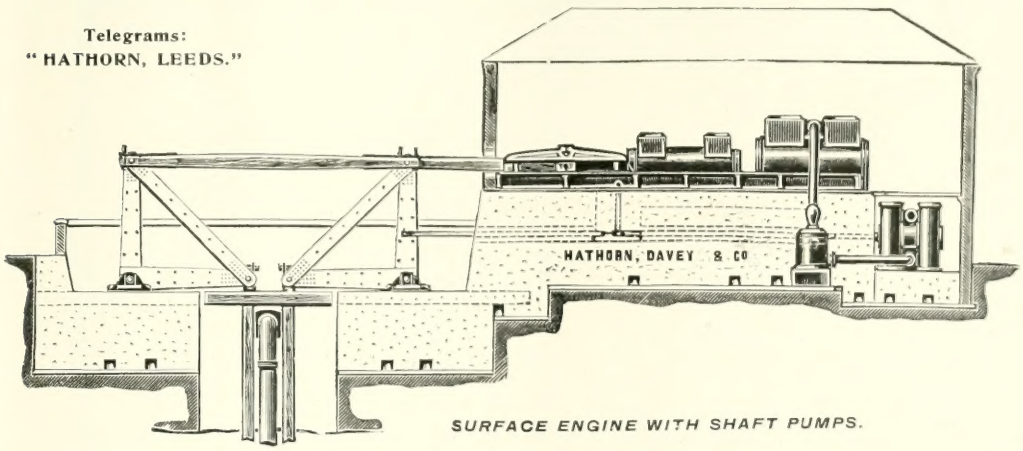

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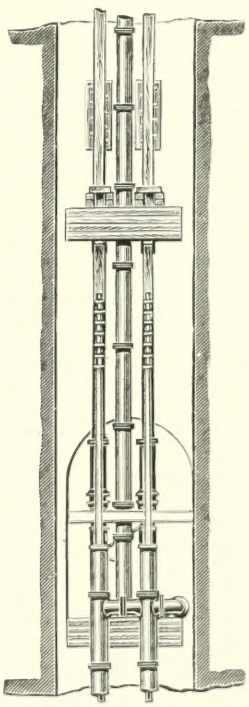

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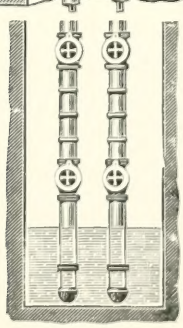

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In order to assure fair treatment to advertisers, each firm is indexed under its leading speciality ONLY.

Advertisers who prefer, however, to be entered under two or more different sections can do so by an annual payment of 5s. for each additional section.

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Parker Foundry Co., Derby.
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[illegible] Supply Co., Ltd., [illegible], London, E.C.
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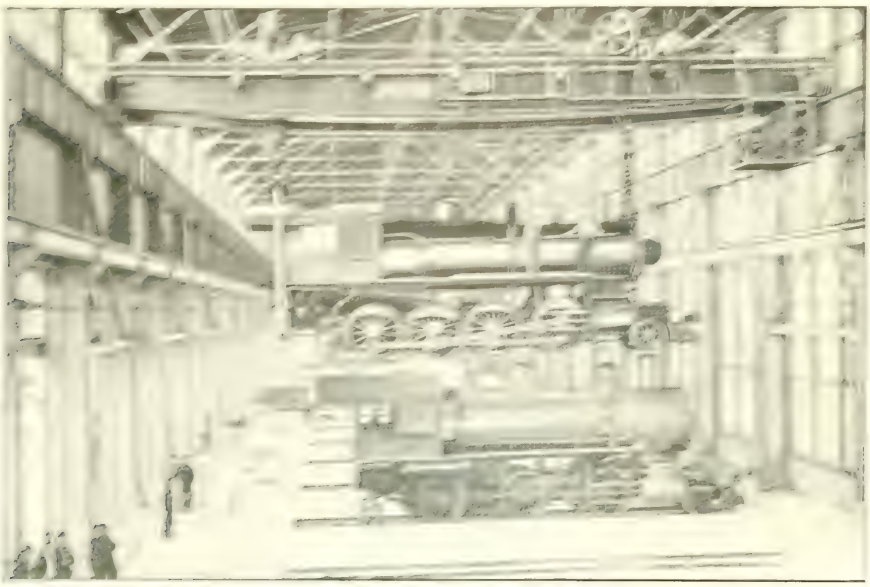
Kirchner & Co., 21-25, Tabernacle Street, London, E.C.



Niles Crane. . . . capacity 100 Tons span 86 ft. 6 in. Installed in the shops of Lake Shore and Michigan Southern Ry. Co., Collinwood, Ohio, U.S.A.

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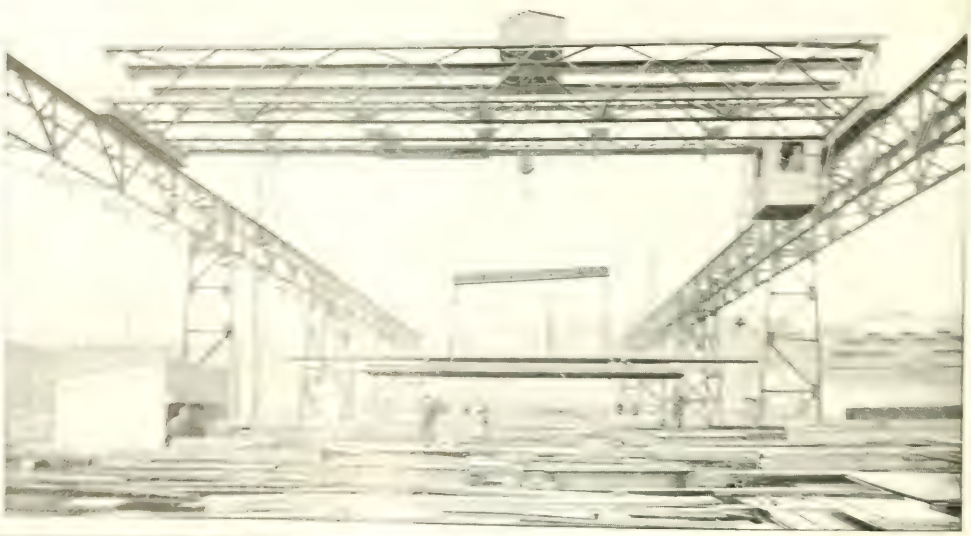

Selig, Sonnenthal & Co.

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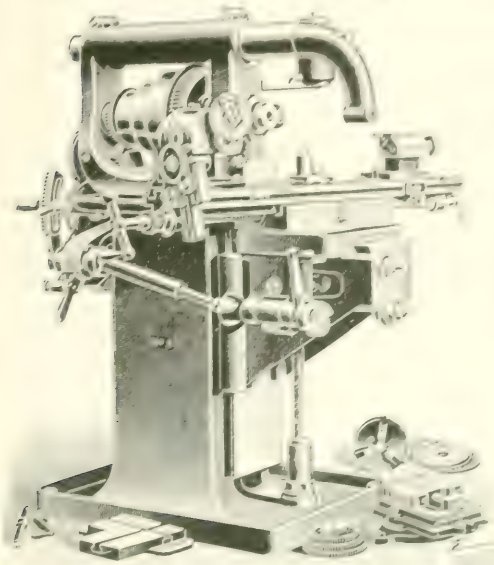
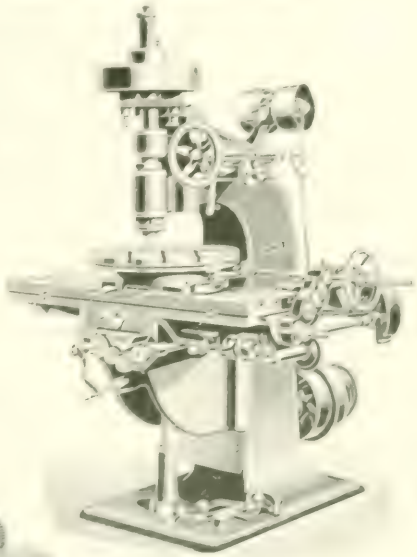
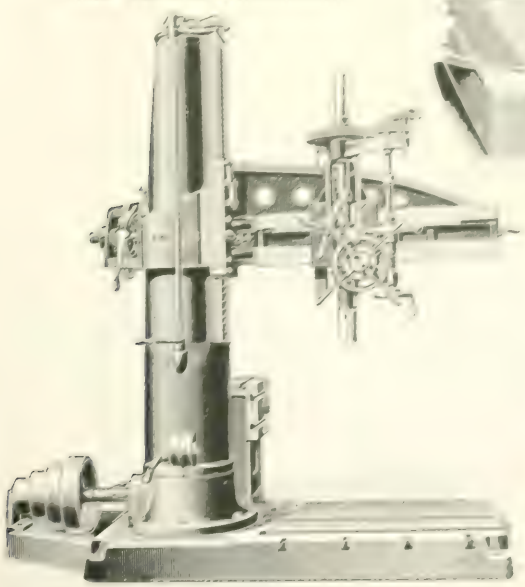


Patent Portable Keyway Cutting Machine,
In Position on Boss of Fly Wheel.

Vertical Milling Machines.



Combination Radial Drilling Machine,
with Tapping Attachment.



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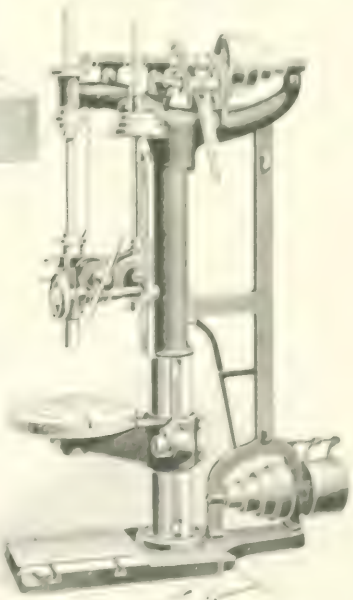
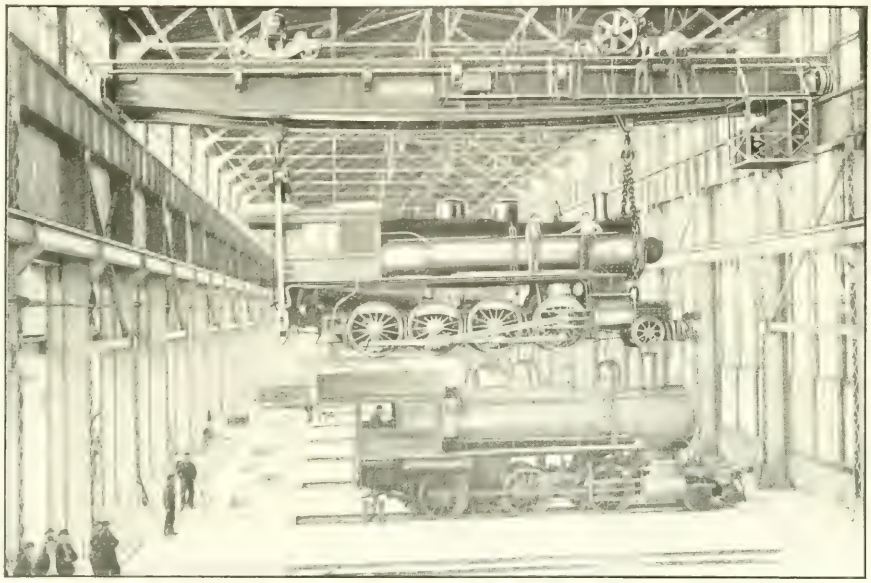


85, Queen Victoria St. & Lambeth Hill, London, E.C.



Niles Crane, . . . capacity 100 Tons, . span 65 ft. 6 in. . . Installed in the shops of Lake Shore and . Michigan Southern Ry. Co., Collinwood, Ohio, U.S.A. . . . . .

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Crane Works, Philadelphia, Pa., U.S.A.

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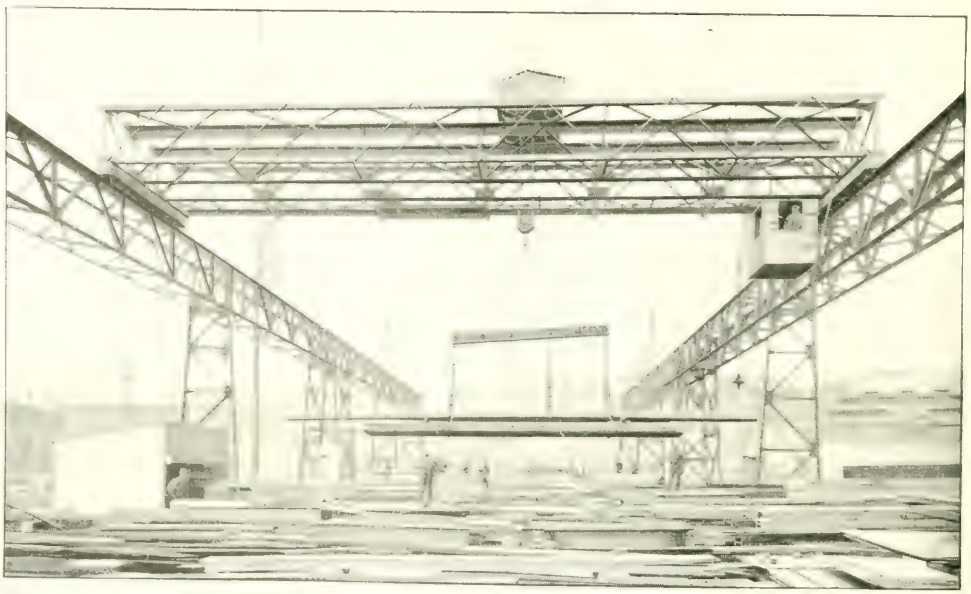

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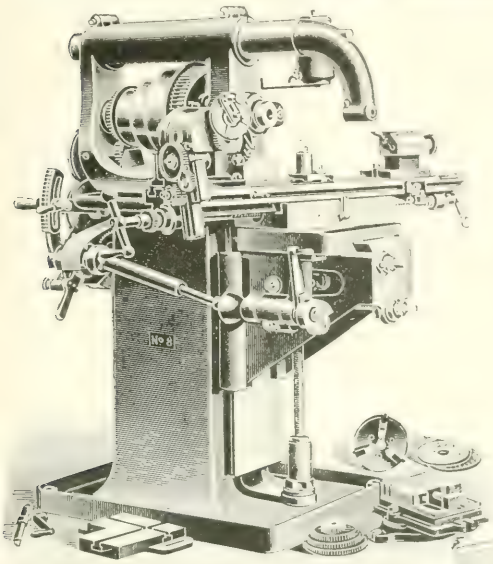
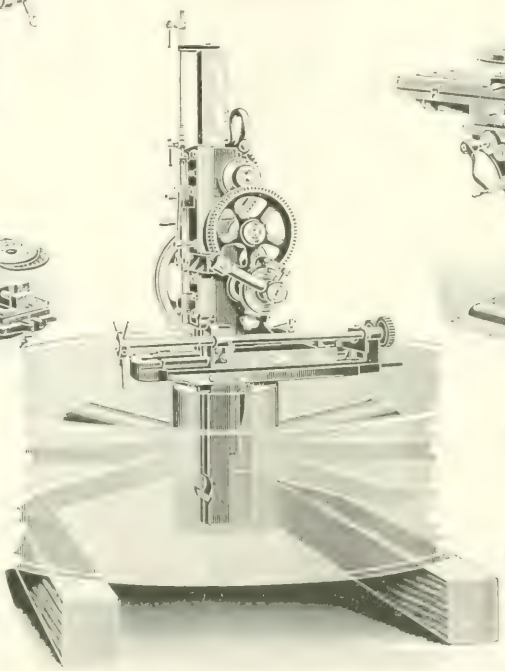
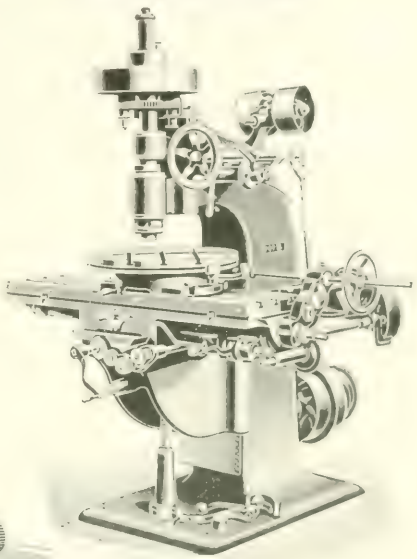


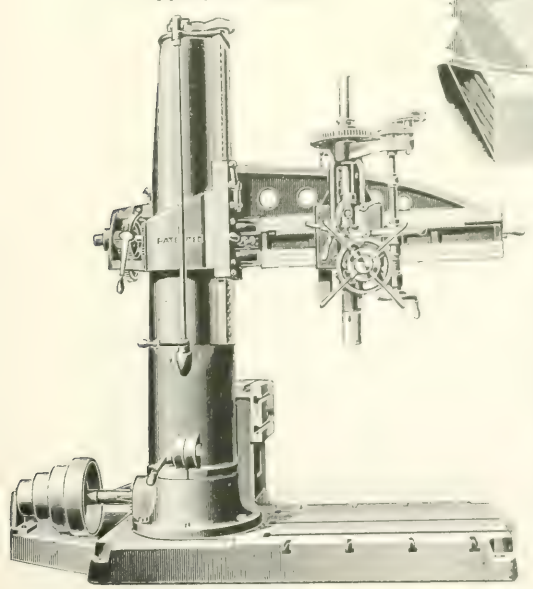
Patent Portable Keyway Cutting Machine,
In Position on Boss of Fly Wheel.



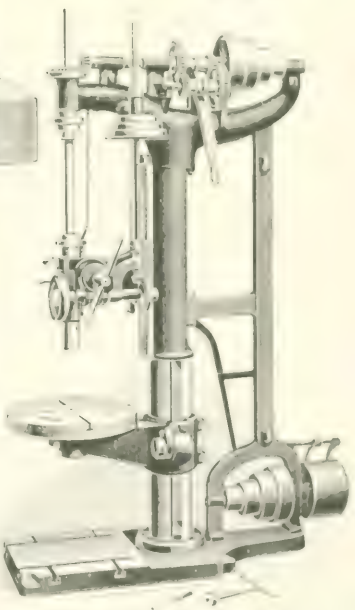
Vertical Milling Machines.



Combination Radial Drilling Machine,
with Tapping Attachment.



Sliding Head Upright Drilling Machines.



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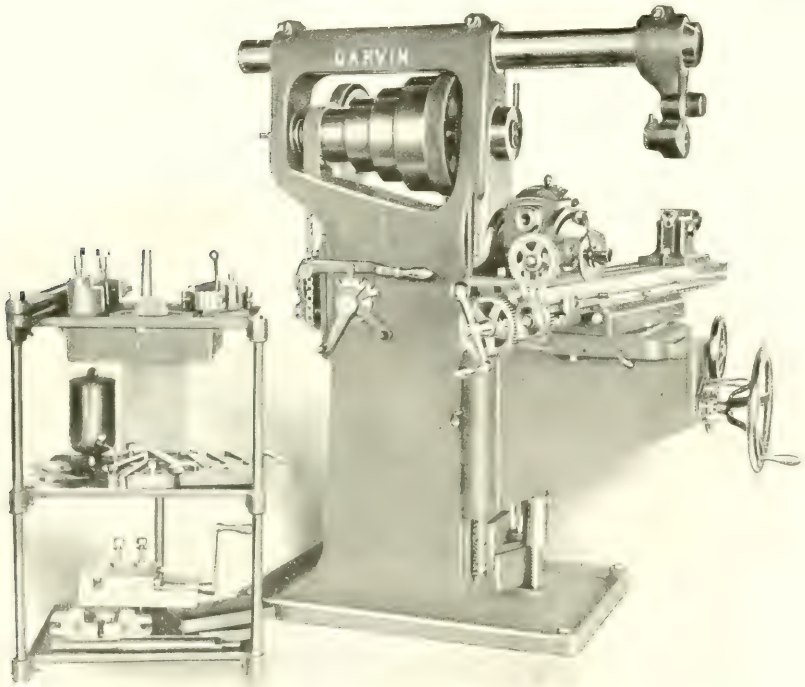

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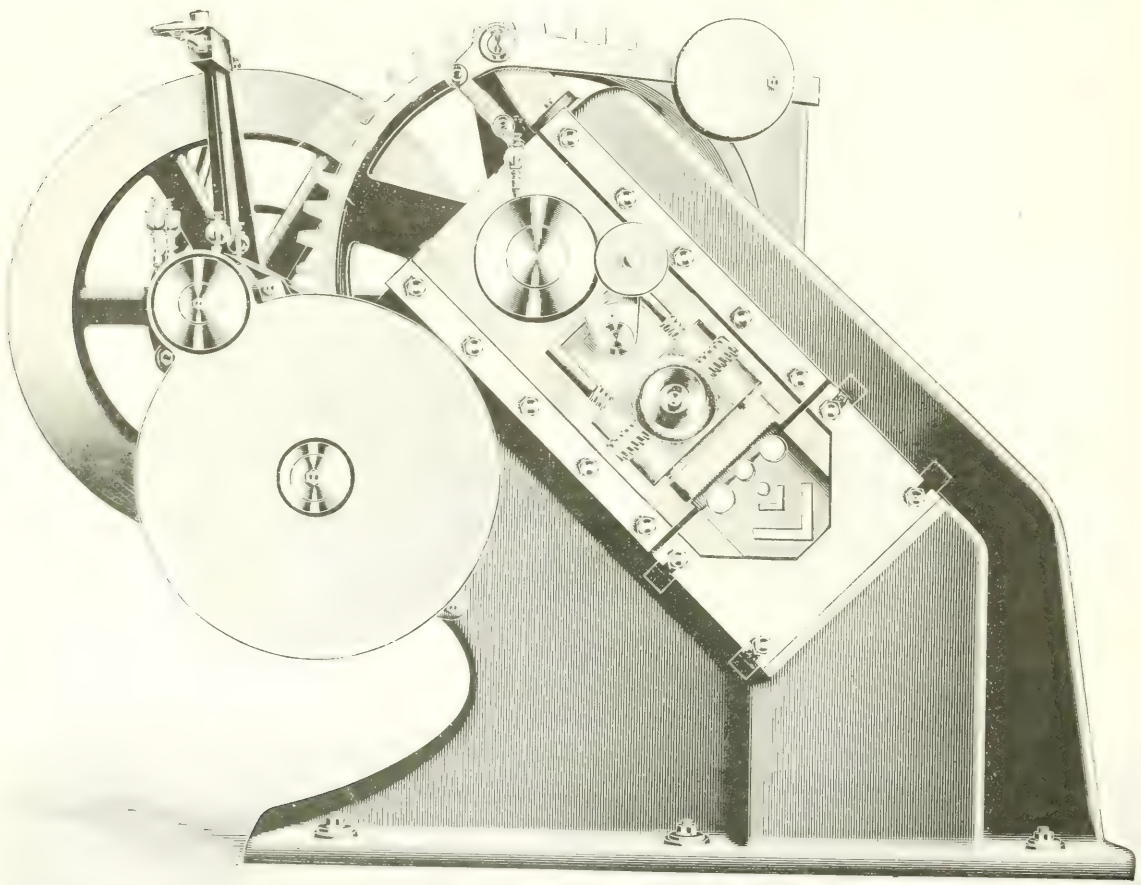

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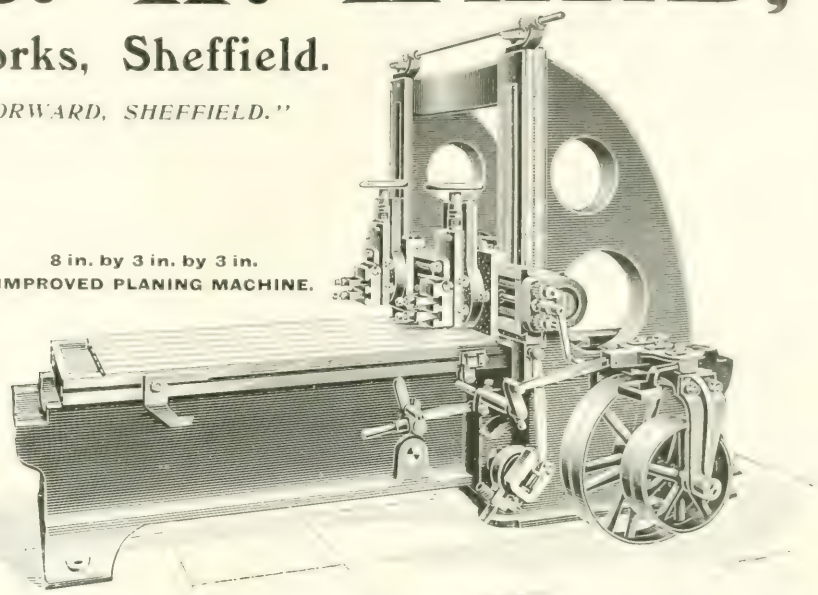

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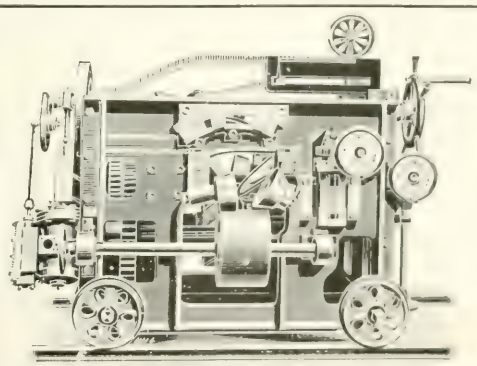

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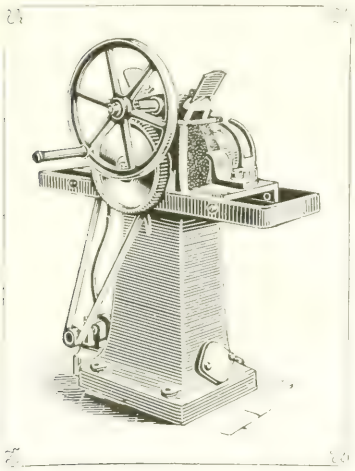

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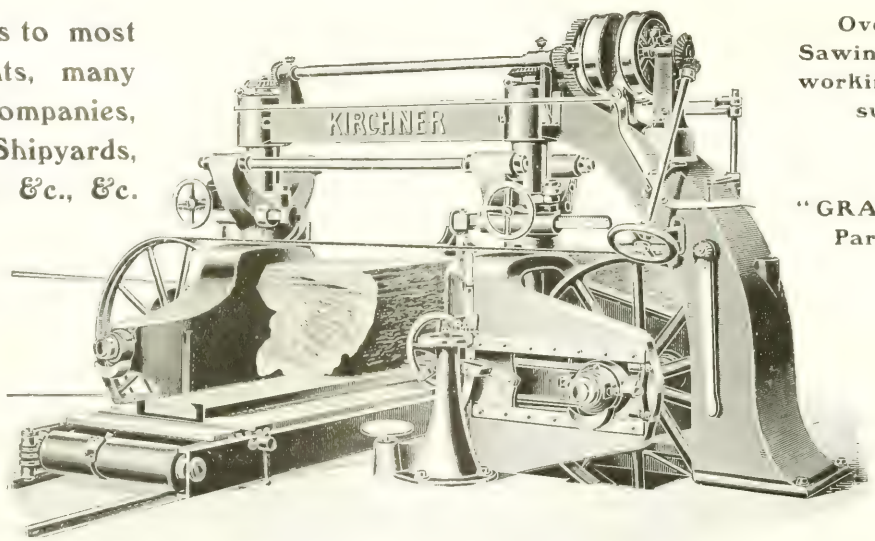

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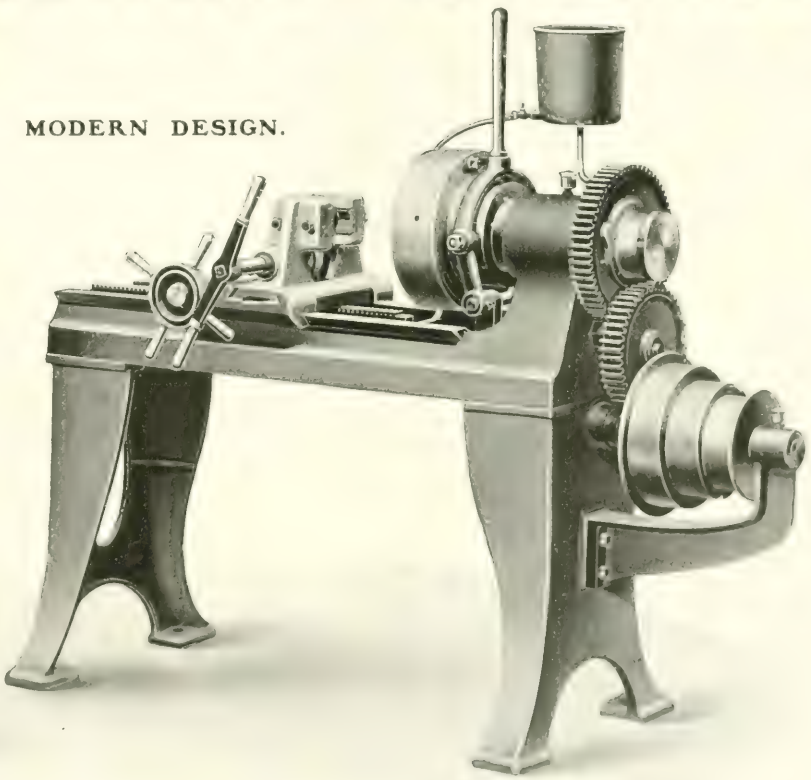

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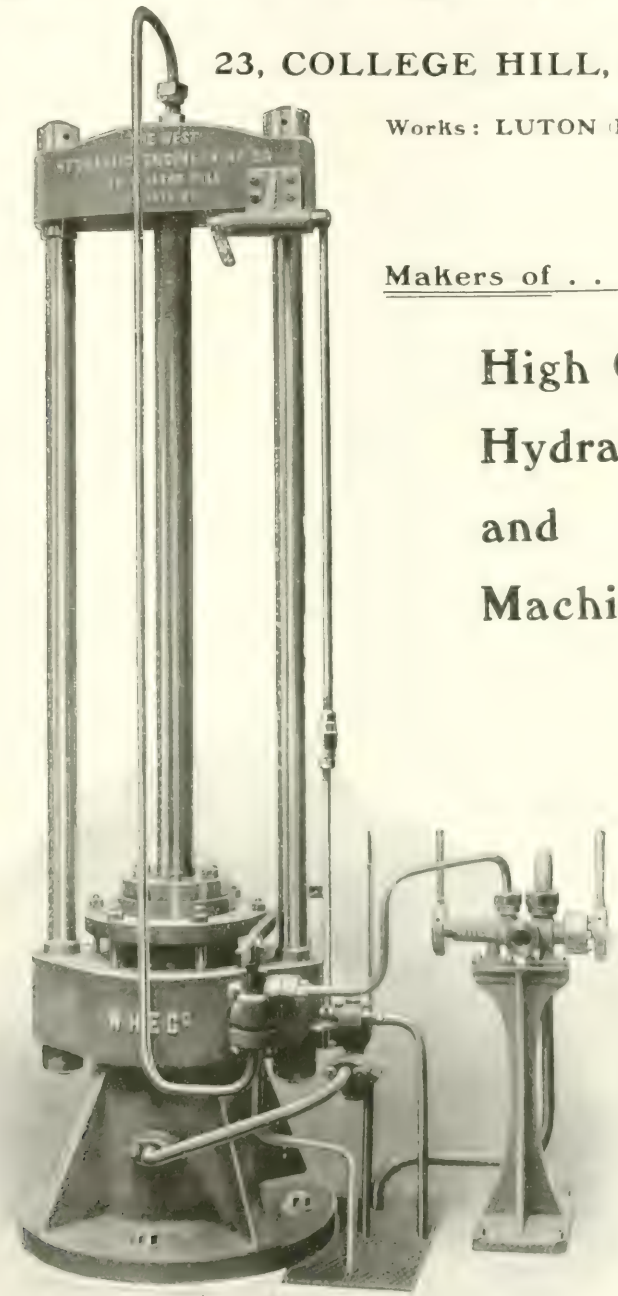

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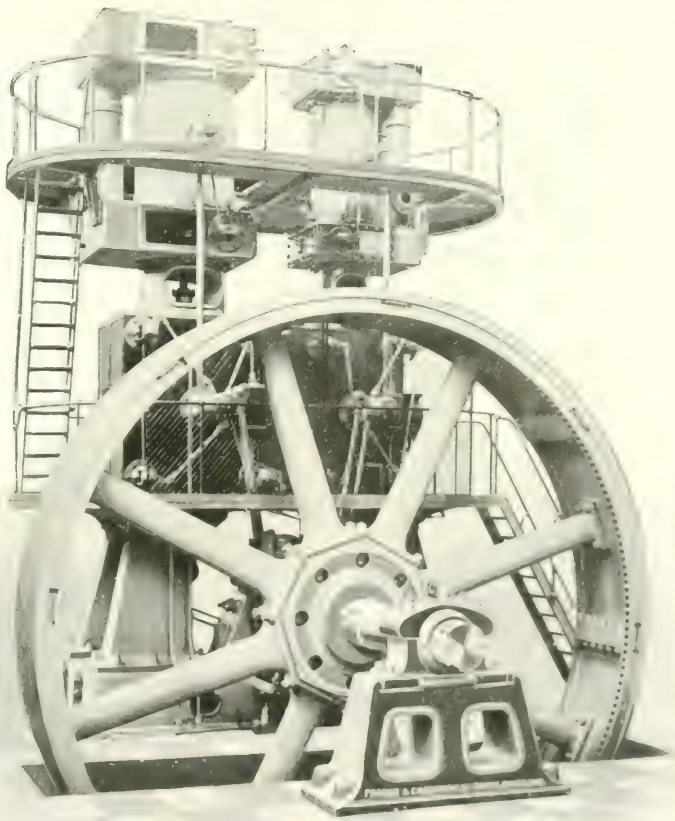

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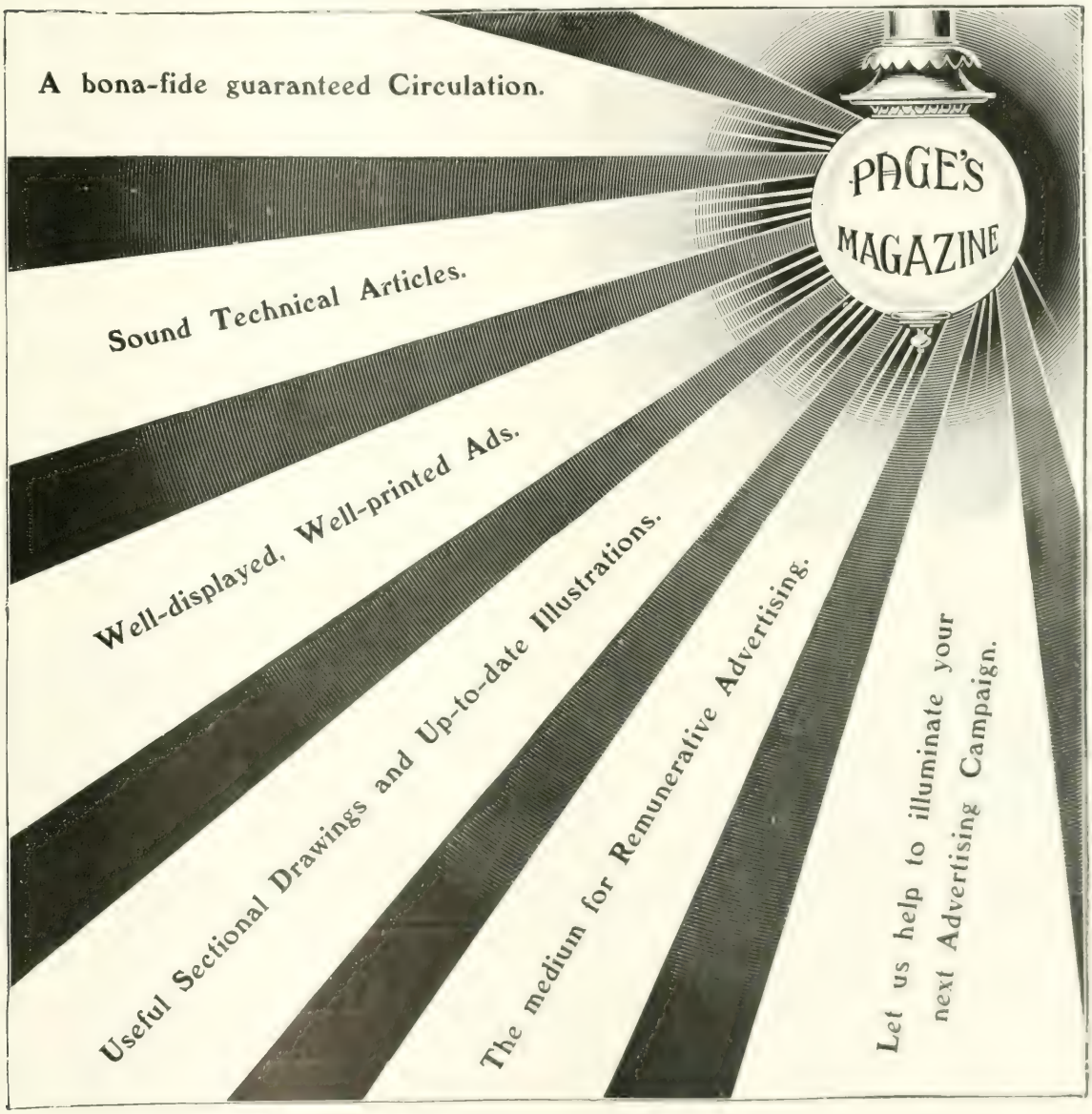

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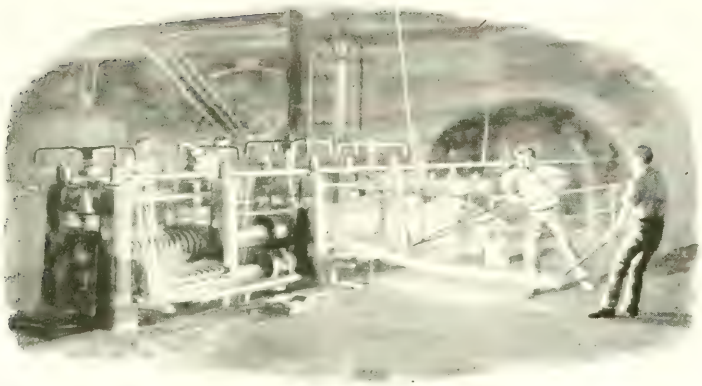

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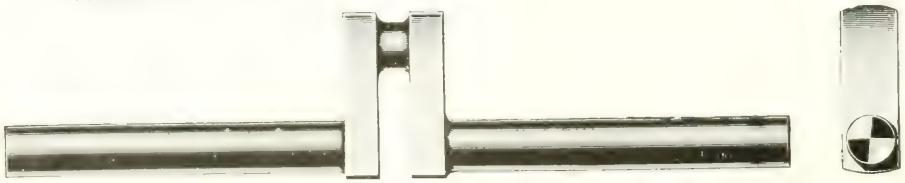

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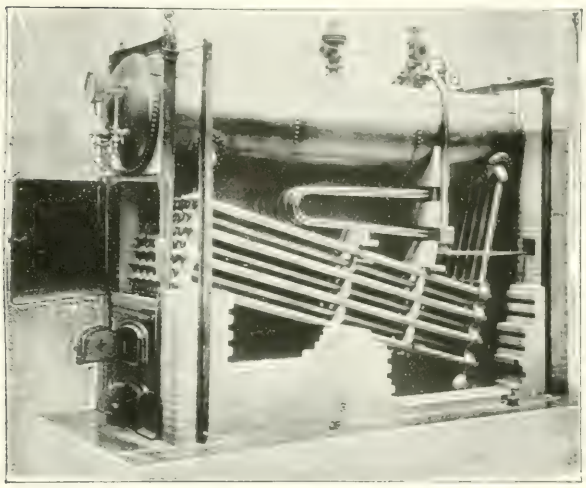

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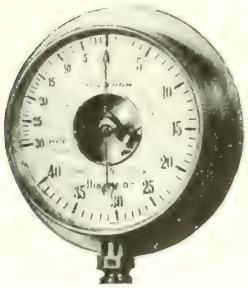

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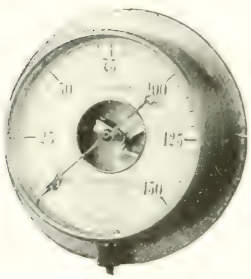

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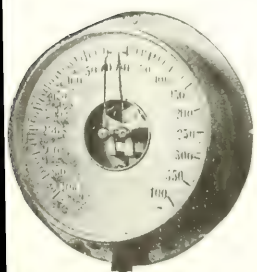

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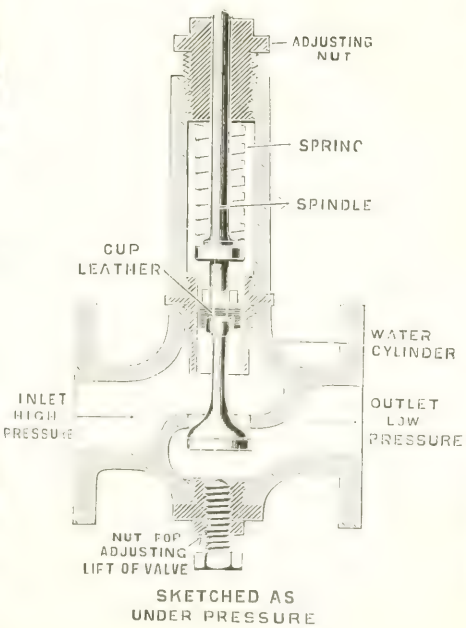

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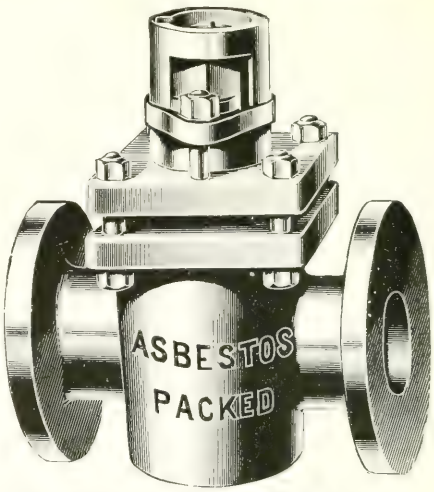

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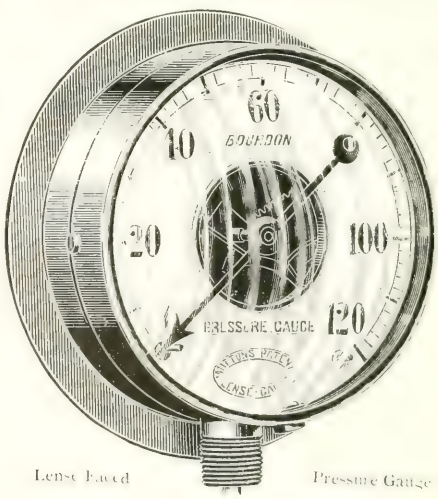

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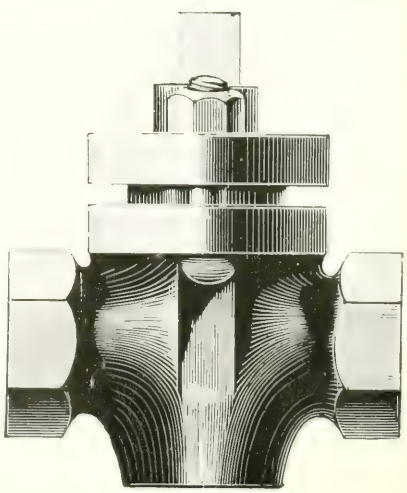

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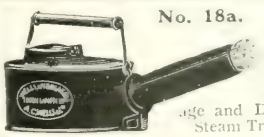

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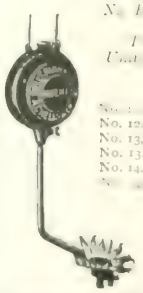

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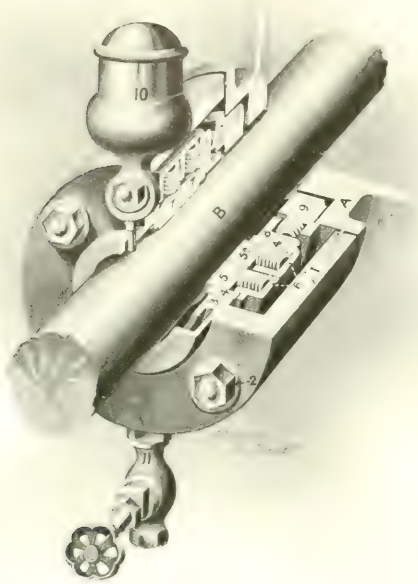

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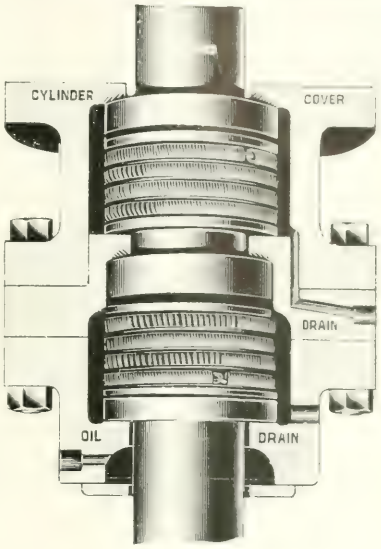

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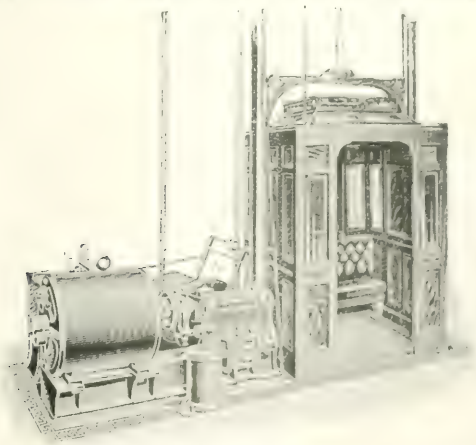

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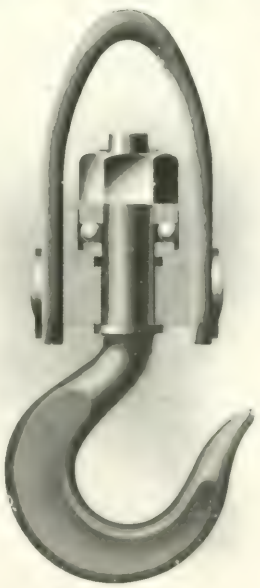

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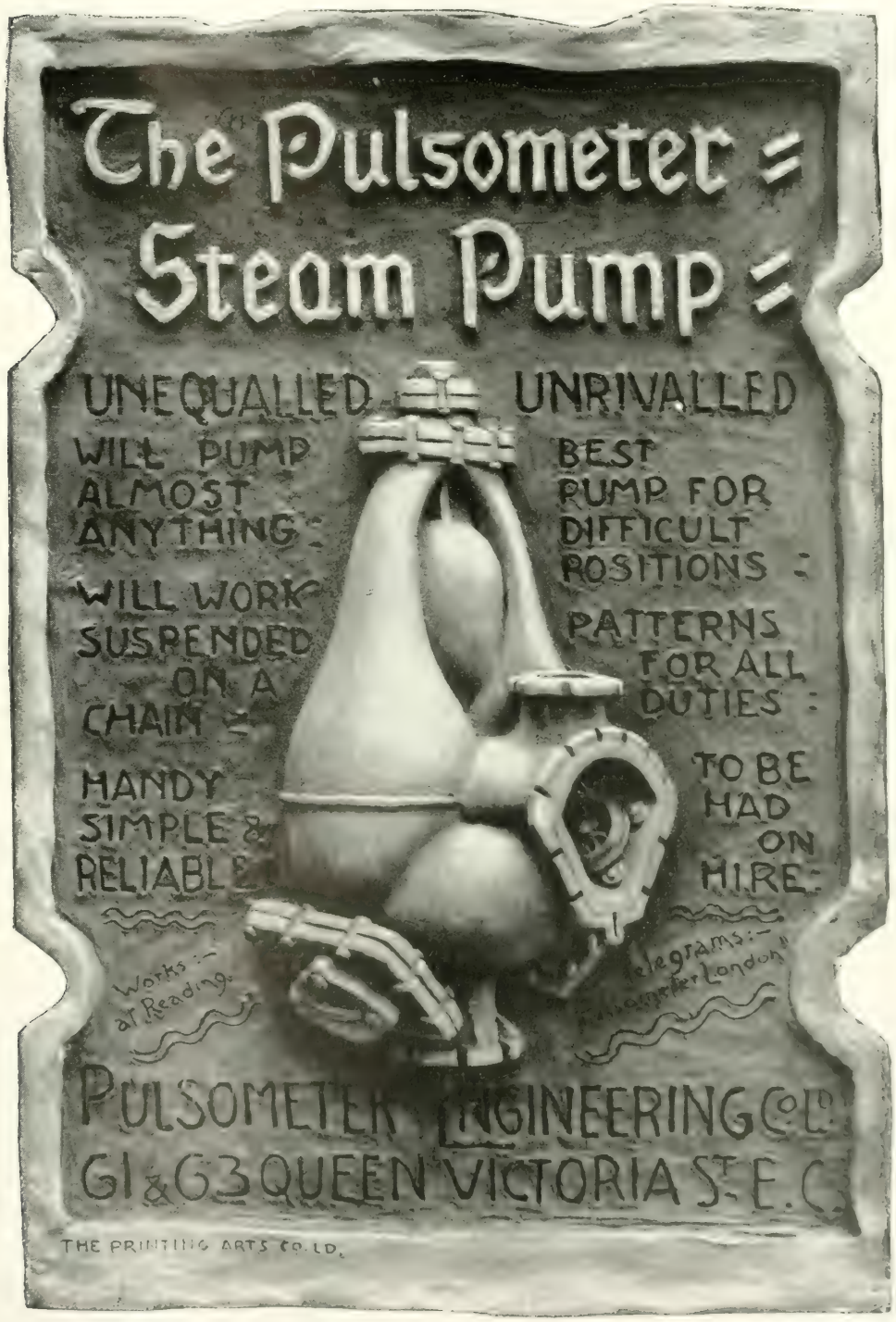
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See article on the Chinese Eastern (Manchurian) Railway.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. III. LONDON, JULY, 1903. No 1.

FIRE PROTECTION OF WORKSHOPS.

BY

J. W. G. SIMONDS.

The author has confined his attention to such apparatus as may be useful to managers of small works who wish to install appliances and organise a system which will enable them to deal at a moment's notice with an outbreak of fire—a system not involving any great expense either in original outlay or upkeep. Mr. Simonds has had many years' experience of fire brigade work, and in a future article will describe the details of a large works' brigade where many permanent firemen are employed. ED.

IN the last few years the necessity for fire protection has undoubtedly been brought home to us by the increasing rates and more searching inspection of fire insurance companies, if not by a far more unpleasant and costly reminder in the shape of a fire, destroying, perhaps, valuable machinery and premises, and upsetting that manufacturing continuity without which no business undertaking can hope to succeed.

WATER SUPPLY.

The first matter for consideration is the water supply. If, as in so many towns having a modern water supply, mains of suitable size, and charged with water under fair pressure, run near the premises, then, of course, one's task is wonderfully simplified. Connections should be run into the works and carried down the centres of all roadways and completely around all buildings, care being taken not to run too close to shop walls, for if this is done it may be impossible to make a connection in case of fire in that shop.

Mains, if carried into works entirely for fire purposes and having no connections taken off for domestic or trade supply, will probably be rated by the water company at so much per hydrant per annum; but if mains have to serve the double purpose of fire and trade supply, then they will probably be metred at the point of entry. I have worked for some years with fire mains the water in which is metred, and, contrary to expectation, have never had any trouble with meters jamming, nor do I think that the flow is crippled to any appreciable extent.

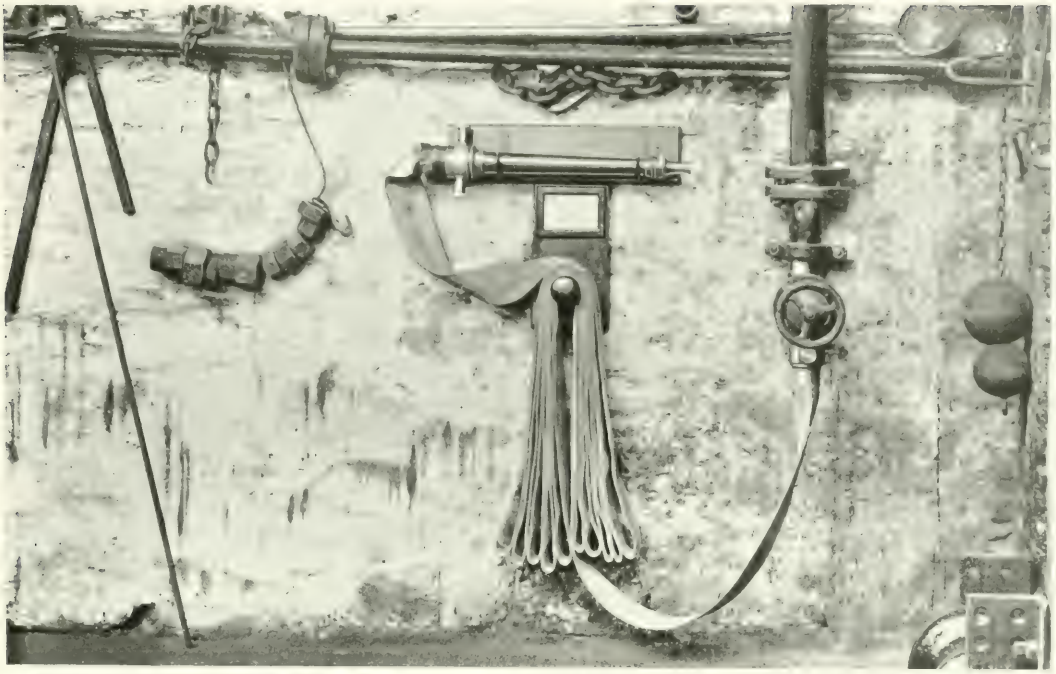
Where mains are metred a very good arrangement, if the water company can be made to agree, is to have a bye-pass connection round the meter, from the pipe entering the meter to the pipe leaving same. This bye-pass to be controlled by a locked and sealed valve. In case of fire, metred water will be used unless the meter is jammed or the uncrippled flow from a direct main is required, in which case the bye-pass valve may be opened. Such an agreement has been entered into with water companies by certain factories, the arrangement being that for every time the bye-pass valve is opened, a certain sum is paid to the water company, and an estimate is taken of the number of gallons used, and this is paid for per gallon over and above the [illegible]

PUMPING ARRANGEMENTS.

Where no mains, or only mains of small size or insufficient pressure are available, it may be necessary to have recourse to pumps either as one's only supply or as an auxiliary to water company's pressure.

These may be either of the fixed type, pumping direct into mains, or portable in the shape of a land steam fire-engine which can work from a hydrant or pond or any other source. A third

A TYPICAL WORKS FIRE STATION—TURNING OUT.



METHOD OF LEAVING HOSE FOR USE WITH INSIDE HYDRANTS.

method, which can only be employed with works having a river or canal frontage, is to have a fire float, this being a barge or tug fitted with powerful pumps.

A fixed pumping engine, no doubt, offers efficient means of keeping a good supply of water in the mains, but it must be driven by a quick steam-raising boiler,* and have someone at hand to start the fires. If driven from a manufacturing boiler, it must be kept constantly under steam, and it must be remembered that engines of this type, when required to deliver large quantities of water, require a large evaporation of water per hour, practice having proved that an engine delivering 1,000 gallons of water per minute will require a boiler evaporating 3,500 to 4,000 lb. per hour; therefore, manufacturing boilers will have to be very large.

The second and third alternatives should, perhaps, rather be discussed under the head of appliances, but, as they are only necessary when mains are not satisfactory, it may be as well to deal with them here.

The disadvantage of a land steam fire-engine is that if your engine is of any power at all, and therefore necessarily somewhat weighty, a pair of horses must always be kept in readiness to move it about. The boiler should always be kept warm by gas or other device, and on receipt of a call, the fires, which must always be kept ready laid, should be lighted.

The third alternative will only be possible where works have a river frontage. Under these circumstances, it will be found most useful, an unlimited supply of water being available, and the pumps being practically at the water level, there is no great suction lift to contend with, as there would be with a land steamer working from a jetty with a river at low tide.

If your float be simply pumps and boiler, placed upon a barge, a simple means of propulsion is to couple several lines of hose to your pumps, placing the branches with large-sized nozzles (say inch) in crutches fixed in the stern, then if your pumps be started a fair rate of

* When a boiler is referred to as a quick steam-raising boiler, the usual type of fire-engine boiler is meant, such as will raise steam to 100 lb. per square inch in eight to twelve minutes from cold water, or in three to four minutes from water heated by a gas or oil burner or any system of heater.

ANOTHER VIEW OF HOSE CART, WITH TWO MEN AT WORK.

HAND FIRE PUMPS AND FIRE BUCKETS, FOR SMALL WORKSHOPS, BY MESSRS. MERRYWEATHER AND SONS, LTD.

progress may be attained, up to four or five knots in still water.

A more elaborate system is, of course, to have a self-propelled boat, say a steam-propelling engine, driven by steam from the pump boiler, which, being quick steam-raising, will (provided it is kept warmed to about boiling point) in a very few minutes have sufficient head of steam to get under way. Theoretically, a small electric motor and accumulators seem almost ideal, as the float may thus be got under way at a moment's notice, but in practice the accumulators are found to give endless trouble.

Before closing the subject of water supply, I would strongly emphasise the absolute futility of putting in small mains for fire purposes. Nothing less than a 4-in. main should be tolerated, and if it is at all conceivable that it may at any time be required to extend your mains, it should be at least 6-in. or 8-in. My rule has been 4-in. for inside hydrants, 6-in. and 8-in. for outside work. Apart from the fact that a small main—say, a 3-in.—is not capable of supplying more than one really good fire stream (2½-in. hose, 1-in. nozzle), it must be remembered that every year the area is becoming reduced by depositions of mud, aquatic growth, and oxidation.

OUTSIDE HYDRANTS.

These may be of many forms, such as plug hydrants, ball valves, and the many forms of valve hydrants, both single and double.

The plug hydrant I suppose may almost be reckoned as a thing of the past, and those who on a cold winter's night have straddled and pulled with crowbar, spoon, and hook, and have at the last succeeded in releasing the plug and getting soaked to the skin will not, I think, be disposed to regret its disappearance.

The ball valves, though almost as old as the plug, are still largely in use, although I doubt if many are being installed. To my mind, the best hydrant is a screw-down stop valve pot hydrant, having either one or two outlets (the outlets having either the Whitecroft instantaneous coupling, or whatever coupling is used on the

hose), controlled by a valve, the spindle of which should be at least one inch square in section. Small section spindles are an abomination—a few turns with a key, the corners wear, the key fails to grip, and your hydrant is useless.

Hydrants are of one or two forms—ground or pit hydrants covered with a plate, or standpost hydrants, the supply pipe of which runs up a post, and ends in a hose connection. The latter are usually controlled by a wheel.

The standpost hydrant is more convenient than the pit hydrant, as it stands up clear of all obstructions, and there is no time lost in removing plates and attaching a standpipe as there is with the pit hydrant; but it has one fatal objection, it is more exposed to the attacks of frost than the pit hydrant. It also takes up more room, and is more liable to damage by travelling cranes engaged in moving material.

PROTECTION OF HYDRANTS FROM FROST.

In such frosts as are common in England, the danger of underground mains freezing is not very great, but at the hydrant one night's hard frost is all that is required to render your hydrant useless. The danger lies in the freezing of the water left standing on the outer or connection side of the valve, and if this part of the hydrant is kept clear, the danger is almost nil. This is done by some makers of hydrants by an automatic relief valve which opens when the hydrant valve is closed, and allows water to escape from the outer side of the valve, closing again when the valve is opened. Another way is to draw the water away with a syringe at the weekly hydrant inspection.

I have found an infallible remedy against frost is to fill all pit hydrants with stable litter at the beginning of winter; the standpost hydrants may also be swathed in hay bands. In my own experience with hydrants of both classes treated as above, I have never known a pit hydrant frozen, but endless trouble is caused every winter by the standpost hydrants freezing.

Hydrants should be inspected at least once every week, inspection consisting of seeing that no material covers the plates, turning on the hydrant until water commences to flow, then syringing water from the valve, and seeing that no dirt or foreign substance is left round the connection. Where the instantaneous connection is used, which depends for its joint upon an india-rubber washer, attention must be paid to this rubber washer to see it is not losing its nature. The life of these washers largely depends upon water not being allowed to stand in the connection.

And now a word as to hydrant keys. As before mentioned, when discussing turning spindles, they should be of large size. All hydrant keys in works should be of one size, this, if possible, to be determined by the dimensions of the spindles of the hydrants in use by the local authorities. All other keys which could possibly be tried in case of fire should be removed, so that when the first fire does occur one may be saved from the *contretemps* which occurred at a large shipyard fire in the North of England. The hose was coupled up, but no key could be found to open the hydrant, and the hydrant eventually was opened with one of an assorted lot of keys borrowed from some neighbouring works. As a consequence, the fire brigade, on their arrival, found the premises so seriously involved that they concentrated their efforts on saving the adjoining property.

INDICATION OF HYDRANTS.

The position of hydrants should be clearly indicated by a tablet fixed to a wall near by. Enamelled iron I find most satisfactory, for, although perhaps the first cost may be a little more than a painted signboard, they never require re-painting, an occasional wash down with a wet cloth being all that is required to keep them clean.

INSIDE HYDRANTS.

All dangerous shops, such as pattern shops, saw mills, joiners' shops, and stores, should be fitted with inside hydrants, and as these hydrants are intended to be used by the men working in the shops, they should be so simple that a person without any previous training can use them. I illustrate one of these hydrants to show the arrangement that I have found most satisfactory. Some people do not agree with keeping hose coupled up to the hydrant, arguing that the water dripping from an imperfect valve, rots the hose. This may be granted, but why have imperfect valves? With the weekly inspection which all hydrants must receive,

leakage can easily be detected and attended to, and, on the other hand, much valuable time may be lost in coupling up, specially in a dark shop and by a man who in the time of emergency may have lost his presence of mind.

Experiments have been tried with hydrants arranged as illustrated to determine the possibility or otherwise of one man getting to work, and it has been found that if the hydrant be opened without even removing the hose from the flaking peg, and the branch taken down from the carriers, a jet may be got by the water finding its way through the hose, and by virtue of the pressure laying the hose in such a way as will allow a clear flow through. Of course, two men are really required to get the best results, one man taking the branch as near the fire as possible ; the other opening the hydrant and then following along the hose to remove kinks.

KINDS OF HOSE.

Hose may be divided into three classes : rubber-lined canvas, unlined canvas, and leather.

The latter, I suppose, has almost entirely died out for fire brigade purposes. Against it were its weight, cost, and necessity for constant attention, and the care it required in laying out to bring the line of rivets on the outside curve.

The reason for lining hose with rubber is to enable it to stand greater pressure than unlined canvas, and also to reduce the loss due to surface friction, but unless the rubber lining is fairly thick, so thick in fact as will prevent it conforming to the threads of the canvas covering, and so rendering it full of small ridges, it does not answer this latter purpose. Hose with a rubber lining thick enough to present a smooth surface to the water when under pressure, is of necessity very heavy, and for a works fire brigade, where the two or three men first on the spot may have to get to work, weight in hose is a great drawback.

Unlined hose is far less expensive, quite as durable, lighter, and more compact than lined hose, and, in fact, to my mind, far more suitable for a works brigade. It should be hand woven, and not too closely woven, because, although a loose woven hose shows a slight loss due to percolation during its first few seconds under pressure, it is far more durable than a closer woven hose.

TESTING HOSE.

Hose when supplied new should be carefully examined for irregularities in weaving ; it should then be tested under pressure, 300 lb. per inch for rubber-lined hose and 200 lb. for unlined canvas being a very fair test to apply.

A test that I have always used for new hose is to put it under a normal working pressure, say 100 lb., and then have it lifted by two men over their heads and thrown down upon a smooth surface, such as an asphalt yard ; any hose not passing this test should be returned to the makers to be replaced, having failed at test.

The above are tests suggested for new hose, but every length of fire hose should be tested, if possible, every six months, and at least every twelve months it should be tested to the highest working pressure it is likely to be subjected to.

CARE OF HOSE.

Hose after use should be carefully drained and dried ; it should be stored in a warm, dry place, as the least damp has a deteriorating effect upon it. If stored in hose-carts or cupboards, the covers or doors should be allowed to stand open occasionally to allow air to circulate about the hose.

REPAIRS TO HOSE.

Any handy man can repair canvas hose, preferably a sailor, or man who is used to using a sail needle. Small holes should be stitched up and thoroughly cleaned ; the following solution should then be applied in three coats, the previous one being thoroughly dry before the next is added :—

125 parts gutta-percha to 625 parts of bi-sulphide of carbon (the gutta-percha to be finely cut up).*

After all three coats of solution are dry, gradually heat the solution with an iron and apply a patch of canvas which has been similarly treated with solution and also heated.

Where a large rent or burst has to be dealt with, it will be found better to cover the part with a collar or sleeve of canvas [illegible] about eight to ten inches long, the inside of which should be coated with solution, the same to be

* This mixture is very inflammable, and must be kept from fire.

put on the length of hose where the sleeve or band comes into contact.

A PRECAUTION.

All hose which, owing to age or other cause, has become unfit for fire purpose should be condemned and destroyed. If an unserviceable length be allowed to remain in your works in the shape of hose it will, in all probability, be that length which is coupled up at your first fire.

CONNECTIONS.

Of the many connections on the market, both instantaneous and otherwise, it is difficult to speak at any length in an article of this sort.

The connections I am at present using are the ordinary instantaneous spring connections, patented, I believe, by Morris, of Manchester, now made by all makers; they give every satisfaction, except that it is impossible to disconnect them when under pressure. The rubber washers also want looking to occasionally.

The style of coupling should, of course, be the same as that used by the local authorities, so that one is not allowed much latitude in choosing couplings.

BRANCHES AND NOZZLES.

The branches usually found most convenient are made of copper, about 24 inches long. Of course, a longer branch may give a better fire stream, but it is not found convenient when working inside a building. Some fire brigades use the flexible leather branch pipe, about six feet long, but it has never appeared to me that any better fire stream is obtained by the use of this branch.

Nozzles should always have a hexagon boss, the round boss pattern being most difficult to unscrew from the branch.

Spare nozzles should be carried in all appliances because, although $\frac{7}{8}$-in. or even 1-in. may be found most satisfactory with one or even two branches at work, a time may come when, with four or five branches at work, a $\frac{3}{4}$-in. or even $\frac{1}{2}$-in. may be required.

When installing inside hydrants, attention should be paid to the sizes of nozzles on the branches, for where a $\frac{7}{8}$-in. may be the nozzle for the ground floor, a $\frac{1}{2}$-in. may be required on the top storey.

APPLIANCES.

Works in which a land steamer is used will, of course, carry much of the hose upon the steamer, but for use from hydrants and as a reserve to your steamer, some small handy appliance is required capable of being drawn by one or two men. After trying many different sorts of hand appliance, including large and small hose reels and many of the different forms of hose cart, I am most favourably impressed with the Metropolitan Fire Brigade pattern of hose cart. This cart consists of a light box divided into two compartments, each fitted with a lid secured with a hasp, staple, and toggle. The larger compartment on the near side is known as the hose box, and carries about 500 ft. of hose (unlined). The smaller compartment on the off side is known as the gear box, and carries requisite gear and appliances. These hose carts are lightly and strongly built and mounted on springs; they are undoubtedly far ahead of hose reels in their lightness of running, handiness, and strength, and an advantage they possess not found in other forms of hose cart is that the lids keep gear and hose clean and dry.

The following is a useful list of articles to be carried in a hose cart, the total weight of a hose cart so stowed being 5 cwt. :—

In Hose Box—
500 ft. hose, with branch, and $\frac{7}{8}$-in. nozzle.

In Gear Box—
1 spare branch, $\frac{3}{4}$-in. nozzle.
1 swift (smoke driving branch), $\frac{5}{8}$-in. nozzle.
3 spare nozzles, 1-in., $\frac{3}{4}$-in., and $\frac{1}{2}$-in.
1 hand pump, with hose and nozzle.
1 felling axe.
3 lapping leathers and lines.
1 long line, 60 ft.
1 short line, 40 ft.
2 lashing lines, 10 ft.
1 crowbar.
3 spare fire-alarm glasses.
3 buckets (collapsible canvas).
2 standpipes, carried in hooks fore and aft of box.
1 hydrant key, hung on hooks under box.
2 copper lamps, carried on head of cart.
2 brass station numbers on head of cart.

The hose should be flaked down in the cart with all hose coupled, with the branch coupled up, laid on top, pointing aft. The hand-pump mentioned above is a small copper force pump, surrounded by an air space which acts as an

air vessel, and keeps the jet, which may be thrown to about 25 ft., constant. They are at times most useful for extinguishing small fires which may be out of reach of a bucket and yet not sufficient to justify the opening of a hydrant and consequent damage by water.

CORRIDOR ENGINES.

These engines are an enlarged form of hand pump fixed in a tank or reservoir mounted on wheels. They are kept full of water, and can be easily run about and worked by one man. They are fitted with a folding handle, which enables two men to carry them upstairs. They hold about fourteen gallons of water. They can be strongly recommended for the protection of offices, as they are quite capable of dealing with a small fire, and the damage from water is not excessive.

CHEMICAL FIRE ENGINES.

A chemical fire engine consists of a closed vessel filled with water in which is dissolved bicarbonate of soda. In this vessel is suspended a bottle containing sulphuric acid, which, by means of a piston or other device, can be broken when required for use. A few feet of hose and nozzle are provided controlled by a stopcock. On the breaking of the bottle, the following chem cal action takes place :—

$$2\,NaHCO_3 + H_2SO_4 = Na_2SO_4 + 2\,CO_2 + 2\,H_2O.$$

The pressure generated in the vessel drives the water out with considerable force, and the water being impregnated with carbonic acid gas, is, no doubt, slightly more effective than plain water.

These engines can be recommended for standing about in stores, wood-working shops, offices, and other places specially liable to fire, a convenient size being about six to seven gallons.

FIRE ALARMS.

To my mind, the greatest factor in fire protection and the point to be arrived at above all others is to make certain that in case of fire a "call" shall be sent with certainty and promptitude to the persons whose business it is to deal with fires, whether it be your own private fire brigade or the brigade of the local authorities, and how often, even with an efficient private fire brigade, this point is lost sight of. I know of some works whose card of fire instructions commenced as follows : "Any person discovering a fire will at once inform the night shift manager." It went on to explain other matters, such as ringing of bells, calling of firemen, etc. Unfortunately, the first fire of any importance occurred on a Sunday night, and the manager not being there, no one was informed, or, apparently, not for an hour or more.

Most works of any size, and situated in or near a town, will be connected with the local telephone service, which will, in its turn, probably be in communication with the town brigade. Now this forms in itself a means of call, always provided access can be had to this telephone night or day, and that there is someone whose duty it is to ring up, be he caretaker, watchman, or fireman. A convenient arrangement would be to have fire alarms ringing up to the same room as your telephone, provided you have not a fire station where a regular duty is kept.

As to pattern of fire alarms, I have little to say. Many firms supply them, or they are very cheaply installed by anyone with a knowledge of electric bells and wiring. One word, however. Do not be tempted for economy's sake into having a system with a common wire ; each alarm point must have a separate wire, or endless trouble and false alarms will arise ; one point out of order and the whole lot are useless. Such a system may be cheap, but it is not to be recommended.

Fire alarm boxes should be made as conspicuous as possible, being painted red, and their position may be marked at night by a lamp having the words " Fire Alarm " marked upon it in red.

AUTOMATIC SPRINKLERS.

Although I have had no experience with automatic sprinklers, I feel that an article of this sort would not be complete without some mention of this appliance.

I have been present at various times at tests of these sprinklers, and they have always seemed to perform their work very satisfactorily. They are undoubtedly fully capable of holding a fire in check, and the automatic fire alarm, which is a special and most useful device in the system, calls attention to a fire having started. Perhaps the most eloquent testimony to the value of

appliance can have is the large rebate allowed by fire insurance companies, for it has certainly not been my experience that fire offices allow any reductions unless they have very good grounds for so doing.

THE STAFF.

In this article I do not propose to discuss arrangements in which a large staff of permanent firemen is kept, but it must be quite clear from what I have already said, that there must be someone whose duty it is not only to pass on a call where there is a fire alarm system, but to be responsible for the efficiency of the fire extinguishing apparatus. Such efficiency can only be secured by regular periodical inspection, and for this purpose there must be someone who can be held responsible. His regular work would be : Testing fire alarms every day (twice in bad weather) ; testing inside hydrants once a week ; testing outside hydrants once a week ; testing hose every six months. And over and above this he has all the cleaning and repairs to do. I may suggest that the two or three night watchmen usually found in most works might most conveniently be turned into a fire brigade. Say, for instance, there are three, two on night shift and one on day (taking their turns of day shift, of course) ; now here we have the very numbers required, a watch kept at night, and one man for the day routine work of the brigade.

Men acting as firemen should always be given a neat fireman's uniform, not the uniform of some volunteer fire brigades, in which a man always appears to be a bristling mass of silver epaulettes and whistles, but the plain blue uniform as worn by the men of the London Fire Brigade ; a man in uniform always has more respect for himself and his work if raised above and distinguished from the ordinary workman. And, moreover, a fireman should always be noticeable.

Over and above the few permanent firemen that may be employed, there should, of course, also be an auxiliary brigade of men drawn from the shops and drilled, say once a week, by the permanent men. For each drill they attend they should be paid a small retaining fee ; these men should be compelled to live near the works, and on some prearranged signal, such as the blowing of a hooter or ringing of a bell, must at once proceed to the works' fire station.

CAUSES.

To deal with causes of fires at any length would, I am afraid, occupy more space than will be allowed me in this article, and most, if not all, of them can be obviated by the exercise of a little judgment and common sense, but there is one cause on which I have been lately making experiments, which I think is not generally known, and which must be common in engineering and painters' shops—that is the spontaneous ignition of oil-impregnated waste.

It must be borne in mind that oils such as rape, linseed, and tallow are more dangerous in this respect than the various mineral oils, although the mineral oils will burn more fiercely when once ignited. The risk of fire arising from the spontaneous ignition of oily material is greater the more readily oxidizable the oil. Mineral oils being practically incapable of oxidization, do not heat at all, consequently, there is no danger from them, and, moreover, when mixed with fatty oils in sufficient proportion, they prevent the risk of fire arising from spontaneous ignition of the mixture.

The most dangerous oils are the following :—

Linseed (boiled linseed being particularly bad).
Cottonseed.
Olive fatty acids.
Oleine.
Mixtures of 50 per cent. cotton, 50 per cent. olive.
Mixtures of 25 per cent. cotton, 75 per cent. olive.

A method of testing is as follows : waste saturated with the oil to be tested is placed in a chamber, the air of which is kept heated to 100° C. By means of a thermometer held in the waste the temperature may be read off.

The safe oils, such as pure olive, will not be found to rise much above 100° C., but the dangerous oils, such as cottonseed, will continue to heat, and may rise to as much as 250° C., at which point the thermometer must be withdrawn. It has been laid down that any oil which, when tested in this way reaches 200° C. in two hours may be regarded as extremely dangerous, and special precautions must be taken in any shops in which such oils are used.

BRITISH LOCOMOTIVES FOR ABROAD.

BY

CHARLES ROUS-MARTEN.

The general aspect of the subject was dealt with in the June issue, the author showing that British locomotives, in spite of certain pessimistic utterances inspired by rivals, are the finest in the world, proportionately to their theoretical power. The present article continues the survey of locomotives built at Glasgow for foreign service.—Ed.

II.

CONTINUING in alphabetical order my review of the great British locomotive builders whose works are situated in Glasgow, I come next to Messrs. Neilson, Reid and Co., of the Hyde Park Works. Few, if any, of our British locomotive builders have contributed more largely to the supply of colonial requirements than Messrs. Neilson, who also have left a permanent mark on the locomotive history of the Mother Country. Like their erstwhile rivals and present partners, Messrs. Dübs and Co., with whose work I have already dealt, Messrs. Neilson have built some of the most celebrated express engines running on the Midland Railway. As instances, I need only cite the celebrated "800" and "1502" classes, of each of which Messrs. Neilson supplied thirty in the years 1870 and 1880 respectively; all of them have given good accounts of themselves, and are still in regular working.

Abroad the products of the same firm have also been well in evidence. I have referred already to the fine express engines built by them a few years ago from the designs of Mr. J. F. M'Intosh (Chief Mechanical Engineer of the Caledonian Line) for the State Railways of Belgium. In New Zealand, whose somewhat curious locomotive history I outlined in my previous article, Messrs. Neilson's engines have always been prominent in respect of their excellent work and of their economy in the matter of repairs. When the 3-ft. 6-in. gauge was adopted as the standard for New Zealand, replacing the 5-ft. 3-in. gauge of the Canterbury Province and the 4-ft. 8½-in. gauge of Southland, some of the earliest engines constructed to fulfil the new requirements were obtained from the Hyde Park firm. They were mostly of small dimensions, the "C" class having saddle tanks with 2-ft. 6-in. wheels four-coupled, and cylinders 9½ in. by 18 in.; the "D" class had 3-ft. wheels four-coupled, cylinders 9½ in. by 18 in., and leading Bissel bogie; the "F" class were larger saddle tanks, having six-coupled wheels 3 ft. in diameter, cylinders 10½ in. by 18 in. Subsequently Messrs. Neilson supplied a batch of far larger and more powerful engines, the biggest indeed seen in New Zealand for some years. They were tender engines of the "Mogul" type, having six-coupled 3-ft. 6-in. wheels, leading pony truck, cylinders 14 in. by 20 in., and six-wheel tenders. These last were often employed upon express duty as that was understood in the colony before the arrival of the engines especially built for the service; but whatever the type of engine supplied by these builders to the New Zealand Government Railways I have invariably heard them spoken of in terms of the highest praise alike for their efficiency and their economy—even after the

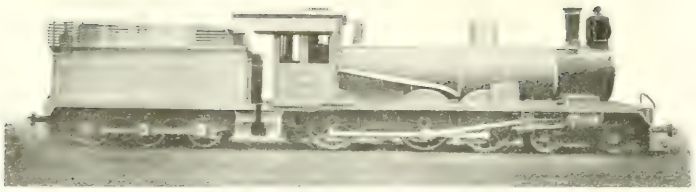


FIG. 1. GAUGE, 3 FT. 3½ IN.

ENGINE: Diameter of Cylinders, 14 in. Stroke, 20 in. Heating Surface, in Tubes, 965 sq. ft.; Firebox, 75 sq. ft.; total, 732 sq. ft. Working pressure, 160 lb. per sq. in. Diameter of Wheels, 4 ft. 3½ in. and 2 ft. 3 in.
TENDER: Capacity of Tanks, 1,770 gallons. Fuel space, 240 cub. ft.

American engines had won such strong popularity — and personally I have many notes of excellent performances by them.

ENGLISH ENGINES ON ASIATIC AND AFRICAN RAILWAYS.

During the past year a number of handsome and excellent locomotives have been constructed at the Hyde Park Works for various Asiatic and African railways. Six of these I now illustrate. Fig. 1 shows a very fine engine of the ten-wheeler or "4-6-0" type, suitable for either passenger or fast goods work on the metre gauge. Its six-coupled wheels are 4 ft. 3½ in. in diameter, driven by outside cylinders 14½ in. by 20 in., which are supplied with steam from a boiler possessing a total heating surface of 732 square feet and a steam pressure of 160 lb. for every pound of effective steam. It is fitted with copper firebox and brass tubes, and weighs 29 tons 17 cwt. in working order. The tender has a water capacity of 1,770 gallons and fuel space of 240 cubic feet. It weighs 20 tons 3 cwt. loaded. Thus the total weight of engine and tender in working order comes to exactly 50 tons. The engines of this type have been supplied to the Perak Government railways of the Malay Peninsula. The next engine to be noticed, although also constructed for the metre gauge, is of a very much larger and more powerful class. It, too, is of the ten-wheel 4-6-0 order, but its coupled wheels are 5 ft. in diameter, its cylinders 15 in. in diameter, with a 22-in. piston stroke; it has 1,003 square feet of heating surface and a working steam pressure of 180 lb. per square inch, while it weighs in working order 32½ tons. Like the other engine, it has brass tubes and copper firebox. The six-wheel tender has space for 180 cubic feet of fuel, while the tanks have a water capacity of 2,000 gallons. The tender loaded weighs 22 tons 19 cwt. The engine and tender are built for

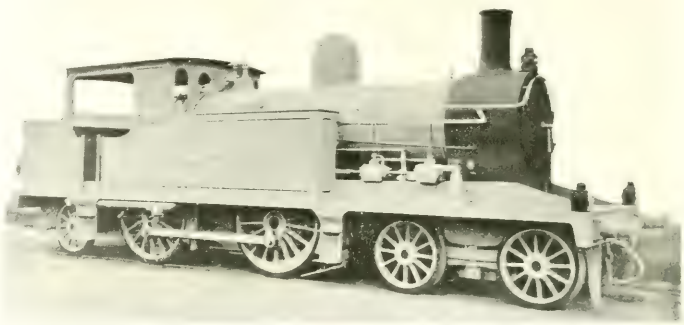


FIG. 3. GAUGE, 5 FT. 6 IN.

Diameter of Cylinder, 17½ in.; Stroke, 24 in. Heating Surface, in Tubes, 1,158 sq. ft.; Firebox, 124 sq. ft.; total, 1,282 sq. ft. Working pressure, 160 lb. per sq. in. Diameter of Wheels, 5 ft. 7½ in., and 3 ft. 7 in. Capacity of Tanks, 1,245 galls. Fuel space, 80 cub. ft.

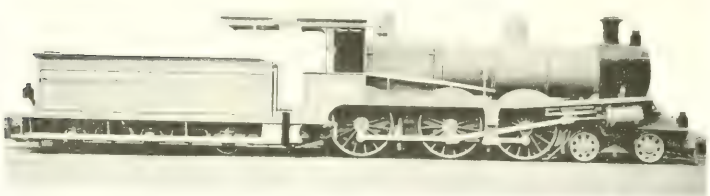


FIG. 2. GAUGE, 3 FT. [illegible] IN.

ENGINE: Diameter of Cylinders, 15 in.; Stroke, 22 in. Heating Surface, in Tubes, 938 sq. ft.; Firebox, 65 sq. ft.; total, 1,003 sq. ft. Working pressure, 180 lb. per sq. in. Diameter of Wheels, 5 ft., and 2 ft. 4½ in.
TENDER: Capacity of Tanks, [illegible] gallons. Fuel space, [illegible] cub. ft.

FIG. 4. GAUGE, 3 FT. 6 IN.

ENGINE: Diameter of Cylinder, 18½ in.; Stroke, 24 in. Heating Surface, in Tubes, 1,184 sq. ft.; Firebox, 131 sq. ft.; total, 1,315 sq. ft. Working pressure, 180 lb. per sq. in. Diameter of Wheels, 4 ft., and 2 ft. 4½ in.
TENDER: Capacity of Tanks, 2,850 gals. Fuel space, 90 cub. ft.

the railways of India, and are shown in fig. 2

Another Indian engine turned out by Messrs. Neilson is for the 5-ft. 6-in. gauge. It is a large ten-wheel tank, with inside cylinders 17½ in. by 24 in., 1,280 square feet of heating surface, steam pressure of 160 lb., four-coupled driving wheels 5 ft. 7½ in. in diameter, a leading four-wheel bogie, and a single pair of carrying wheels in the rear. The weight of this fine engine loaded is exactly 60 tons. In many respects it bears considerable resemblance to the latest type of English Great Northern tank engines, as will be seen from fig. 3.

IN SOUTH AFRICA.

For the 3-ft. 6-in. gauge railways of South Africa, the Hyde Park Works have built three types of locomotive possessing uite extraordinary power for so narrow a gauge. First may be mentioned a tender engine of the twelve-wheeler or 4-8-0 type, which has eight 4-ft. whee's coupled, and a leading four-wheel bogie. The cylinders, placed outside, are 18½ in. in diameter, with 24-in. piston stroke. This gives these engines

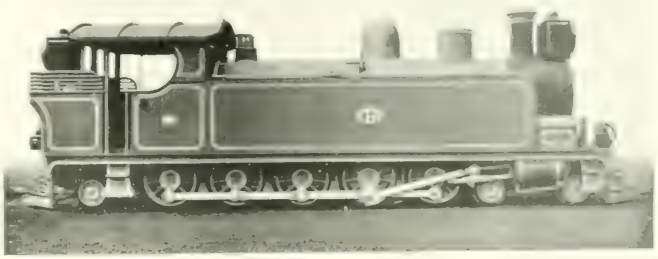


FIG. 6. GAUGE, 3 FT. 6 IN.

Diameter of Cylinder, 19 in.; Stroke, 27 in. Heating Surface, in Tubes, 1,358·71 sq. ft.; Firebox, 134·70 sq. ft.; total, 1,493·5. Working pressure, 175 lb. per sq. in. Diameter of Wheels, 3 ft. 9 in., and 2 ft. 1½ in. Capacity of Tanks, 1,720 gals. Fuel space, 160 cub. ft.

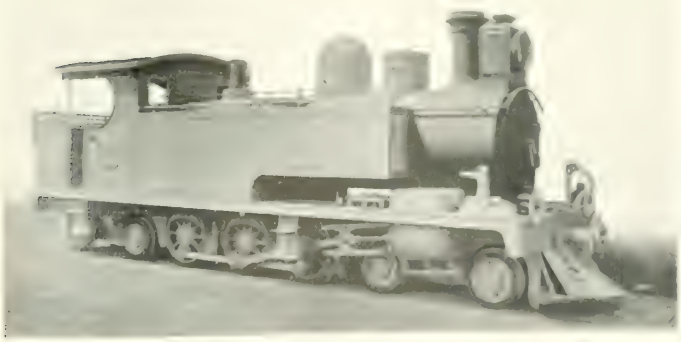


FIG. 5. GAUGE, 3 FT. 6 IN.

Diameter of Cylinder, 15 in.; Stroke, 22 in. Heating Surface, in Tubes, 803 sq. ft.; Firebox, 72 sq. ft.; total [illegible] Working pressure [illegible] Diameter of Wheels, 3 ft. 2 in. [illegible] Capacity of Tanks, 1,000 gals. Fuel space, 90 cub. ft.

[illegible] every pound of effective pressure in the cylinders, while the adhesion weight cannot be less than about 40 tons, so that the engine should possess huge haulage power. It has a gigantic headlight to illumine its way across the veldt. The engines of this class have gone out to the railways of Cape Colony, and are illustrated by fig. 4.

[illegible] engine, also for the 3-ft. 6-in. gauge: [illegible] It has [illegible] cylinders with a 22-in. stroke, six-coupled wheels [illegible] heating surface [illegible]

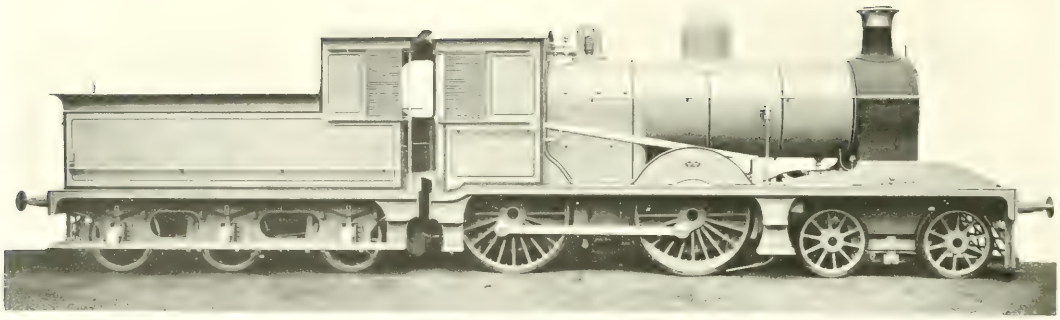


FIG. 7. EIGHT-WHEEL BOGIE EXPRESS ENGINE. GAUGE, 5 FT. 6 IN.
For the North Western Railway of India. The cab is provided with louvre bounded side shutters, owing to the tropical climate.

pressure of 175 lb. per square inch, and a total weight of 43 tons 2 cwt. In this case both the firebox and the tubes are of copper. It is illustrated by fig. 5.

A TITANIC ENGINE.

Lastly comes another tremendous tank engine, probably one of the biggest—if not *the* biggest—ever constructed for the 3-ft. 6-in. gauge. Of the ten-coupled, or "decapod," or 4-10-2 type, it therefore runs upon no fewer than sixteen wheels, and has the enormous weight of 73 tons. The ten-coupled wheels are 3 ft. 9 in. in diameter; the cylinders are of vast cubical capacity, being 19 in. in diameter, with a stroke of 27 in. They take steam from a boiler which has 1,493 square feet of heating surface, and works with a steam pressure of 175 lb. per square inch. The side tanks will carry 1,720 gallons of water, and the coal bunkers can receive 160 cubic feet of fuel. From the dimensions quoted, it will be observed that the tractive power of this titanic locomotive is something quite exceptional, the co-efficient of traction being no less than 216, that being the number of tractive pounds exercised by every pound of steam pressure on the pistons. One would imagine that engines of this class would seldom require pilot assistance, even on the steep grades of South Africa.

FURTHER GLASGOW ENTERPRISE.

Third in alphabetical order among the great Glasgow firms now united in probably the greatest locomotive building business that the world has ever seen, is the firm of Messrs. Sharp, Stewart and Co., of the Atlas Works. It involves no disrespect to their partners in the

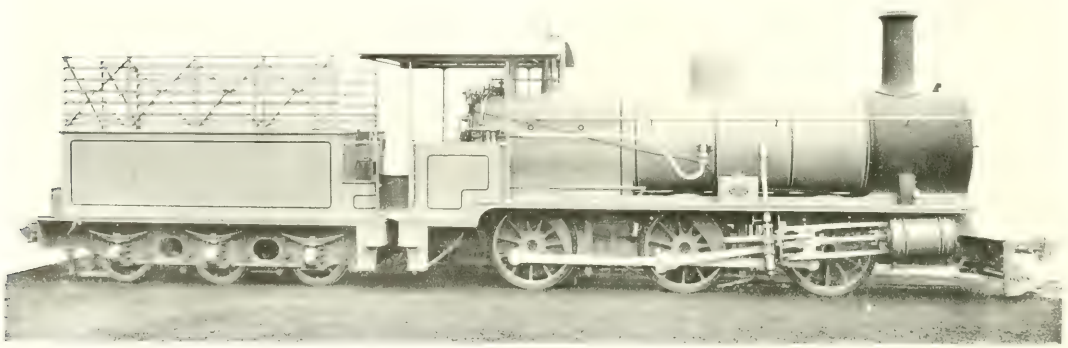


FIG. 8. ANOTHER TYPE OF ENGINE FOR INDIA, OF METRE GAUGE.
The super structure attached to the tender provides for a special class of fuel.

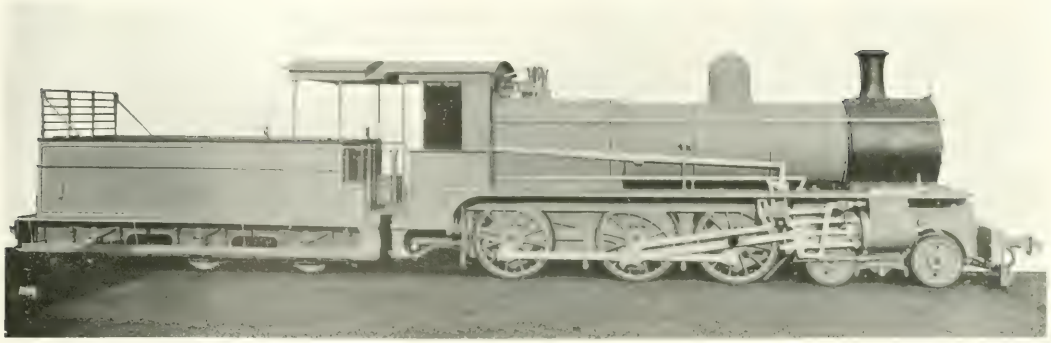


FIG. 9. ANOTHER INDIAN TYPE, INTENDED FOR MIXED TRAFFIC ON THE ROHILKUNA LINE.
With extended firebox and a special sunshade over the front of tender.

new "combine" to assert that the firm of "Sharps" is virtually without a rival in the associated importance and long duration of its connection with railway engineering. Even in the earliest days of British railways—which is tantamount to saying the earliest days of railways anywhere—the name of "Sharp" was prominent among the builders of locomotives. In those early days, and, indeed, until a very recent period, the firm had its theatre of operation in Manchester, the works bearing the same title as the newer ones at Glasgow, namely, "Atlas." The firm itself has undergone several titular changes. Originally "Sharp, Roberts and Co.," it subsequently became "Sharp Brothers and Co.," finally settling down into its present form, "Sharp, Stewart and Co." Early in the "forties," Messrs. Sharp brought out a locomotive type which came into wider adoption as a standard type than any which has since been built. I refer, of course, to the well-known "Little Sharp" engine, which had inside cylinders, usually 15 in. by 20 in., single driving wheels, usually 5 ft. 6 in. in diameter, with a leading and trailing pair of carrying wheels and outside bearings to all the wheels. A few had smaller dimensions and a few larger, but those just given were the most generally in use, and of these locomotives, Messrs. Sharp, Stewart and Co. built large numbers for nearly every important railway in the kingdom, including the Great Western, London, Brighton and South Coast, South-Eastern, Great Eastern, Great Northern, London and North-Western, Midland, and, I believe, several others. Although small, they were singularly handy, and I have often known them used to run expresses on the London and Brighton, South-Eastern, Great Northern, and Midland Railways. Many other famous engines were produced by this firm, perhaps the most widely famous being the "Bloomer" class [illegible]

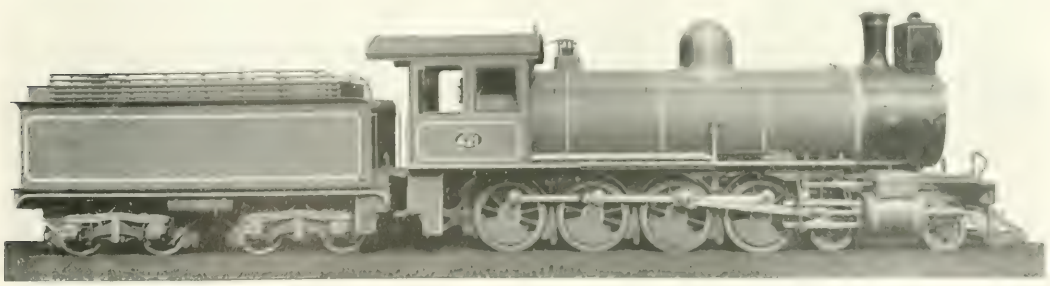


FIG. 10. HEAVY [illegible]

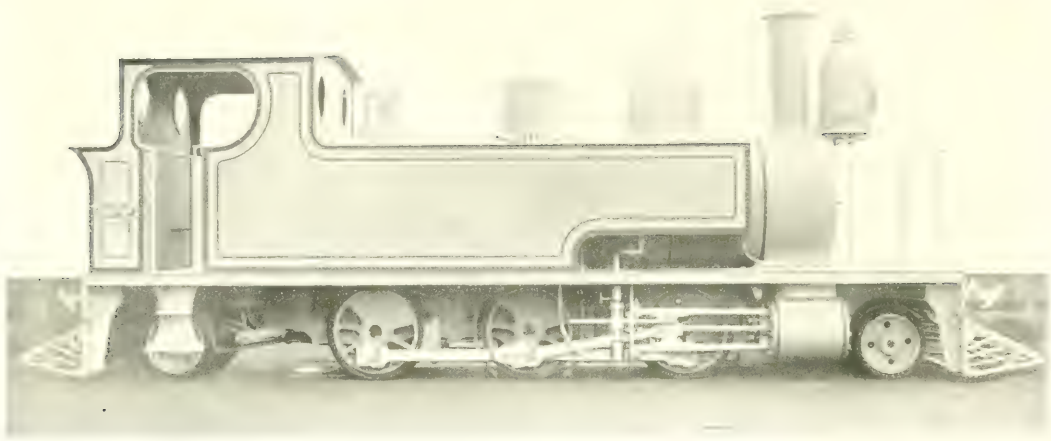


FIG. 11.—TEN-WHEELED COUPLED TANK ENGINE.
For the Government Railways of Brazil.

London and North-Western, which were designed by Mr. McConnell, and had 7-ft. driving wheels, with inside cylinders 16 in. by 22 in., and—unlike the type just previously mentioned—had inside bearings instead of outside to all six wheels. They also had exceptionally large boiler power for the period of their construction—the early "fifties."

In more modern times Messrs. Sharp, Stewart and Co. have constructed numerous engines that have a high reputation for excellence, among which I may instance the "2100" and "2430" classes of 7-ft. coupled bogie expresses for the Midland, that were built to Mr. Johnson's design, and also later still, the new and handsome engines of the "730" class, designed by Mr. Wainwright for the heavy express work of the Chatham and South-Eastern Railway.

AN EXPRESS FOR THE INDIAN MAIL SERVICE.

Like both their partners in the new "combine," Messrs. Sharp, Stewart and Co. have done their full share in providing locomotives for abroad. Among the latest of these is a fine, eight-wheeled bogie express engine for the mail service of the North-Western Railway of India. This is constructed on the 5-ft. 6-in. gauge, and has four 6-ft. 1-in.

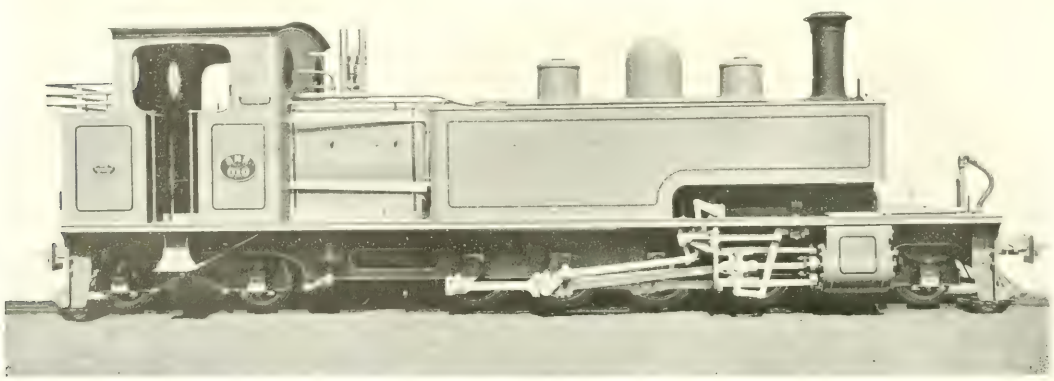


FIG. 12.—FOURTEEN-WHEEL TANK ENGINE.
For the Bengal-Nagpur Railway.

FIG. 13. FOUR-WHEELED COUPLED TANK ENGINE.
For the Cuba and Sant'a Railway.

wheels, coupled with a leading four-wheel bogie; the cylinders, placed inside the frames, are 18 in. in diameter, with a piston stroke of 26 in. This is shown in fig. 7, and it will be noticed that the cab is supplied with louvre-boarded side-shutters, as the engine is to work in the great heat of a tropical climate. The total heating surface is 1,248 square feet, the steam pressure 180 lb. Another type of engine, also intended for India, but for the metre gauge, is one built according to the "F" classification of the Madras Railway, but has been re-designed with frames inside the wheels instead of outside. It runs upon 3-ft. 6½-in. wheels, all being coupled, and has outside cylinders 14 in. by 20 in. The tender is fitted with a light super-structure of open metalwork to carry a special class of fuel (fig. 8).

NEW SPECIAL CLASS.

A third type of locomotive lately built at the Atlas Works is intended for mixed traffic on another Indian line, the Rohilkuna, which, like the one just mentioned, is also on the metre gauge. This engine is of a new special class. It belongs to the type styled in America "the ten-wheeler," or 4-6-0, and has outside cylinders, 14½ in. by 20 in., with 4-ft. coupled wheels, and 180 lb. steam pressure. It has an extended firebox, solid bogie wheels, and a special sun-shade over the front of the tender (fig. 9). A very heavy eight-wheeled coupled bogie goods engine, with double bogie tender, to run on the 3-ft. 6-in. gauge, has also been built by Messrs. Sharp, Stewart and Co., for the Imperial Railways of the Transvaal and Orange River Colonies. It is a very imposing-looking engine of particularly neat design of the so-called "12-wheeler," or 4-8-0 type, with outside cylinders, 18½ in. by 24 in., 4-ft. coupled wheels, 1,215 square feet of heating surface, 180 lb. steam pressure, bar framing, extended smoke box, with large head lamp and leading cow-catcher, as used in American practice. The pistons have tail rods, and the connecting rod is fluted, of I section. The coupling rods, however, are plain (fig. 10).

A GROUP OF TANK ENGINES.

A [illegible] tank engines, all but one of some what uncommon design, may next be noticed. The exception is an eight-wheeler, four-coupled with leading bogie, for the Guayaquil and Quito Railway at Spanish the metre gauge. It has outside cylinders, 14 in. by 20 in. The others comprise: (*a*) A ten-wheel coupled tank engine, with six [illegible] coupled and leading and trailing radial truck

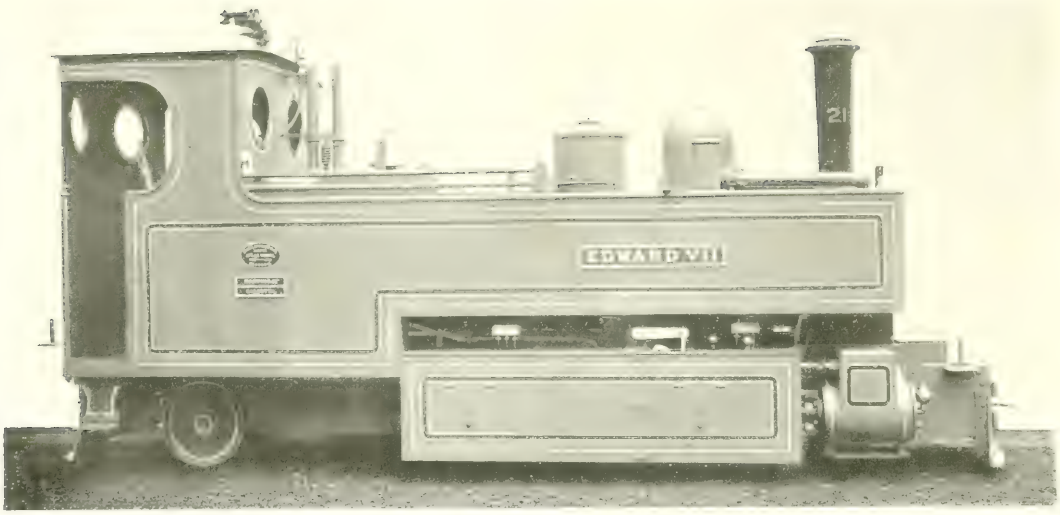


FIG. 14. A SMALL ENGINE OF 2-FT. GAUGE.
For the Howrah Light Railway of India

outside cylinders 14 in. by 26 in., for the Government Railways of Brazil, on the metre gauge (fig. 11). (*b*) A fourteen-wheel tank engine for the Satpura branch of the Bengal-Nagpur Railway of India, which is on the 2-ft. 6-in. gauge. This engine has eight wheels coupled, with a radial truck in front, and four-wheeled bogie behind. The outside cylinders are $14\frac{1}{2}$ in. in diameter, with an 18-in. stroke (fig. 12). (*c*) A four-wheeled coupled tank engine for the Calka and Simla Railway of India, also on the 2-ft. 6-in. gauge (fig. 13). (*d*) A very small and peculiar-looking engine for the Howrah Light Railway of India, whose gauge is as narrow as 2 ft. (fig. 14). (*e*) A four-wheeled coupled tank engine for the Government Railways of Ceylon—2-ft. 6-in. gauge.

(*To be continued.*)

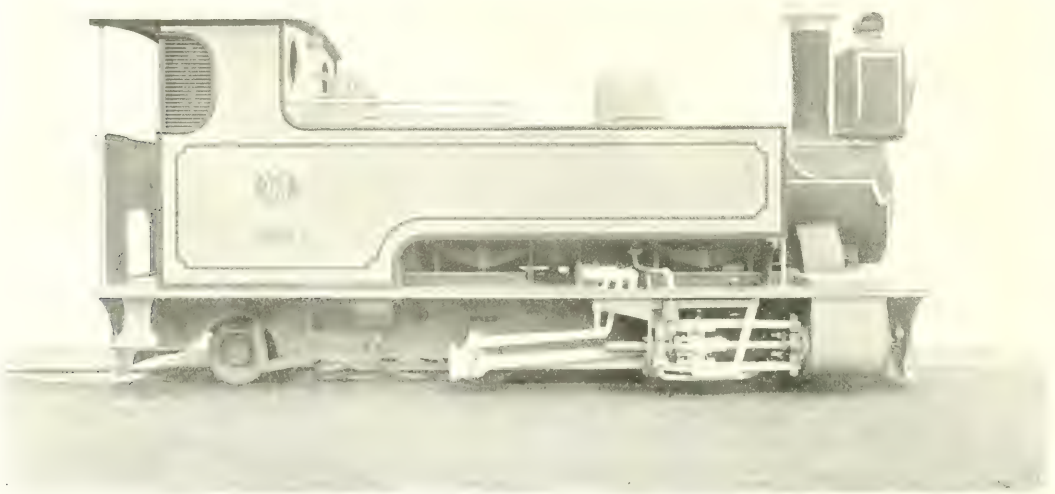
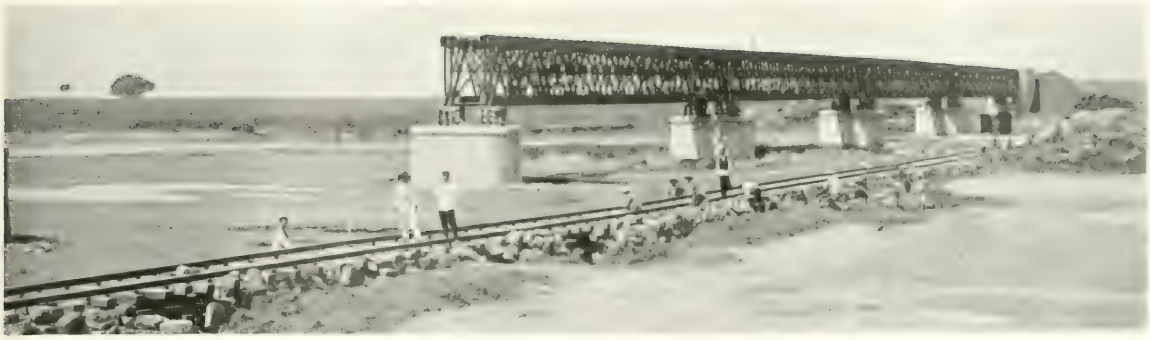


FIG. 15. FOUR WHEELED COUPLED TANK ENGINE.
For the Government Railways of Ceylon



BUILDING THE BRIDGE ACROSS THE RIVER SHAHE.

THE CHINESE EASTERN (MANCHURIAN) RAILWAY.

BY

ALFRED STEAD.

The author contributes a description of the Manchurian Railway, based upon notes personally made during a tour of inspection. The article is illustrated by special photographs hitherto unpublished.—ED.

THE completion of the Russian railway through Manchuria is the finishing touch to Russia's great Trans-Siberian line, which joins Russia in Europe with the coasts of the Pacific. Although the Chinese Eastern Railway Company is nominally a private undertaking, it is financed by the Russian Government through the Russo-Chinese Bank. The total cost of the whole Manchurian line, allowing for rails, workshops, rolling stock, stations and working capital, is 308 millions of roubles. This enormous figure does not include the interest upon the loans raised by the bank for the railway company, and it is certain that further outlay will have to be made before the line is absolutely completed and in working order.

UNPROMISING CONDITIONS.

The railway has been built almost entirely by Chinese labour, directed by Russian engineers and under-engineers. The majority of these are from the Russian provinces near Poland or Germany, and are very intelligent men. It will easily be imagined that there were enormous difficulties to be overcome. There was nothing, save the stone for the bridge foundations and the earth for the embankments to be found in the country itself. To a great extent even labour had to be brought in from Northern China, and the coolies employed had not even the most rudimentary ideas of engineering work. All this notwithstanding, the Russian engineers have succeeded in building over 1,000 miles of line in about two years. It is difficult to estimate exactly the length of time in construction, because the Boxer outbreak of 1900-01 saw the greater portion of the line destroyed, the station buildings burned, and the locomotives and trucks literally torn asunder.

A SYSTEM OF EMBANKMENTS.

Having to bring all their material into the country, the engineers constructed first a temporary track, following closely the contour of the ground and passing the rivers practically on the river bed. Side by side with this temporary track the permanent embankments were constructed and the bridges were undertaken. When everything was ready the track was transferred to the permanent way, and after

MWAFANGO—AN EARLY TYPE OF STATION.
The trees in the background screen the military post which is part of every station.

a time ballasting would complete the work. Labour being comparatively cheap and very unskilled it was found easier to build embankments of great length than to make cuttings through short distances of rocks. This system of embankments was also necessitated by the fact that the southern and central parts of Manchuria are very thickly intersected by rivers, and these, although dry in summer, became raging floods in the rainy seasons. The embankments enable the railway traffic to continue undisturbed, although as much as forty miles of country may be under water, and close by the train the flood may lap the embankment some twenty feet deep. A striking proof of the superiority of the railway over the rest of the country in this respect is to be found that in Southern Manchuria the track has become the recognised highway from north to south by pedestrians, who find the roads impassable because of mud.

LABOUR AT TWOPENCE-HALFPENNY A DAY.

The land for the railway was purchased by the Russians, and a fair price was paid for it. The coolies receive as much as fifty or sixty kopeks a day, while the average wage is forty kopeks. As most of the labour is arranged for through Chinese contractors, it is probable that the workmen receive considerably less than this, but before the railway's advent they only received ten kopeks (2½d.) a day, and they

GENERAL VIEW OF THE 762ND VERST FROM HARBIN ON THE SOUTHERN MANCHURIAN ROUTE.

GENERAL VIEW OF THE ASCENT ON THE 770TH VERST.

can still live on a penny a day. The railway company has installed a very fine system of hospitals and doctors for the workmen. Thus they have very little to complain of, being in fact much better off than formerly.

COMMENCEMENT OF OPERATIONS.

The railway construction was commenced in four places at once. The headquarters of the railway were, and will be, at Harbin, on the Sungari River, where the Russians have constructed a large town. At Harbin the line coming from the Siberian line divides: the one section running east to Vladivostock, and the other south-west to Port Arthur and Dalny. The former section is commonly called the main line, since it was the section originally arranged for, but the line to Dalny is the real main line, being the last link in the railway chain to the Pacific. To Harbin materials were brought by steamer from the end of the Ussuri Railway, on the Amur River. Work was also begun at Port Arthur, at Nikolsk, near Vladivostock, and at the main Siberian line at Kaidalovo. It was this system of simultaneous work that made it possible to complete the line so rapidly. The principal workshops are in Dalienwan, in Harbin, in Hailar, and in Inkou, near Newchwang. These are fitted with American machinery, it having proved to be the most easy to obtain

TEMPORARY BRIDGE ACROSS THE HUN-HE.

rapidly. In these workshops Chinese artificers are to be seen at work under Russian supervision.

DETAILS OF THE TRACK.

The rails employed for the main lines are partly from America, partly from Russia, and run thirty-four kilogrammes to the metre. This is a great contrast to the rails on the Siberian line, which run only twenty-five kilogrammes to the metre. The sleepers are from Korea, America, and Japan, and are laid very closely. The rails are spiked down, but are very firm, it being no uncommon sight in time of flood to see a wash-out spanned by a swinging bridge of rails and sleepers, holding together strongly enough to allow of really heavy weights passing over.

ROLLING STOCK.

During the construction period all the locomotives on the southern sections were of the heavy Baldwin type, weighing some ninety tons with tender; on the northern sections French engines, almost as heavy were used. All the express engines for passenger traffic are ordered in France, and will come from the Russian frontier under their own steam. The passenger coaches for the express trains are constructed partly in France, partly in Belgium, and are very expensively fitted.

BRIDGE BUILDING.

A great feature of the southern section is the enormous number of small bridges, there being sometimes three or four to the mile. These bridges are all of stone or of steel with stone piers, and are most substantial. The steelwork comes from Russia or from Belgium for the most part, and is brought by sea to Inkou, where steamers of considerable draught can berth alongside the railway concession in the Liao River. There is a depth of 70 feet right up to the shore. The bar at the mouth of the river Liao, however, prevents steamers drawing more than 18 feet from passing in Inkou.

AN INUNDATION IN SOUTH MANCHURIA.

A train being pushed across a temporary line by hand, the locomotive being too heavy for the weakened track.

A CUTTING ON THE [illegible]

THE COUNTRY TRAVERSED.

The Manchurian Railway begins at Station Siberia, at the end of the Kaidolovo branch of the Trans-Baikal Railway. The main line of the Chinese Eastern Railway turns to the south-east and passes through a waterless district. Ten versts north of Lake Dalai Nor the line crosses the river Mutinpatop (Turbid River) at the 40th verst. Water fit for drinking is found only at Kulyadghi, into which flows a small stream. All the rain which falls in the district is swallowed up in the dry ground, which is broken up into small ravines. From Mutinpatop runs about thirty versts through plains covered during floods by the River Hailar and Lake Dalai Nor. At a distance of seventy-one versts the line rises on to a sandy, waterless plateau, across which it runs as far as the River Enim, crossing it at the 107th verst. The whole of the plateau is covered with coarse grass, and in some parts the loose sand is drifted by the strong winds to great depths. The rainfall is all swallowed up in the thick layer of sand. To the east of Hailar the line follows the valley of the river of that name and its tributaries, and runs through cuttings into the Hingaan range of mountains.

At the 367th to 370th verst the line crosses the higher eastern range of the Hingaan. At present the line is carried by a zigzag over the top of the hill until the tunnel is completed. This tunnel will be 1 335 sahzen in length (a sahzen is just seven English feet), and lies at a height of 3,500 feet above the level of the sea. In these tunnel works great difficulties have been encountered, frequent streams of water having to be arranged for.

To the east of the Hingaan range the line enters the valley of the river Yal, a tributary of the Nonne River, and follows this valley for some distance. At the 550th verst the valley grows narrower, forming a rocky ravine for a distance of seven versts. This ravine is named Nui-tsi-shan. On issuing from it the line diverges from the River Yal and enters the basin of the River Khur-Khur; at the 631st verst it crosses the Nonne River, fifteen versts from Tsi-tsi-khar. The bridge over the Nonne River

TEMPORARY TRACK RUNNING ON RIVER BED ALONGSIDE THE PERMANENT BRIDGE PIERS.
Half the spans (four) for the bridge may be seen on the embankment across the river.

WASH-OUT ON A TEMPORARY TRACK NEAR LIAO-YAN.
The sleepers holding the rails together.

is one of the three great bridges on the line, the Nonne being very swift and deep. In time of flood the whole country around is inundated, the waters spreading over forty or fifty miles along the railway embankment to the south.

To the east of the Nonne River the line first crosses a marshy plain for some fifty versts, and then for the remainder of its course to the Sungari River, passes through the level and waterless watershed of the Nonne and Sungari Rivers. It is projected to obtain a sufficient water supply along this part of the line by wells.

At the 879th verst the line enters a valley, flooded at high water by the Sungari River, and traverses it for some sixteen versts along high embankments. The Sungari River is crossed by a single bridge opening 445 sahzen. This bridge is the largest on all the Siberian-Manchurian line, and was one of the first of the great bridges to be completed. This bridge lies some distance to the south of the town of Hu-lan-chen.

From the station Sungari the line runs to the town of Harbin. To the east of this town the line to Vladivostock soon enters wooded country, which covers the districts right up to the Ussuri Province. The country gradually becomes rougher and more mountainous. The line follows generally a south-easterly direction, taking advantage of the valleys of small rivers, and crosses the hills, leaving Ninguta twenty versts to the south. It was found necessary in crossing the Tai-ma-go and Pogranitchnaga ranges to construct two tunnels of 175 and 100 sahzen respectively. This part of the Vladivostock line is marked by great embankments of enormous height. At the 1,413th verst the line crosses the political frontier of the Primorsk, and joins the branch line from the Ussuri Railway at Nikolsk.

The Southern Manchurian section starts from the station Sungari near the great bridge over the river of that name, and from Harbin maintains for its whole length a uniform direction to the south-west. As far as the second crossing of the Sungari River the line runs for 121 versts over a level plain, and then gradually ascends to the watershed between the basins of the Sungari and Liao Rivers. The line passes somewhat to the east of the towns of Kuan-chentzi and Chantufu and west of the town of Tielin on the Liao River, and then runs to Mukden, leaving it on the east, and further on to the towns of Liao-yan and Hai-chen. From Tielin to Hai-chen the line follows the valley of the Liao River, crossing numerous small bridges and a whole series of tributaries.

From Hai-chen the line enters the hilly district of the Liaotung peninsula. For eighteen versts the line passes through the Langetahe Valley, scarcely finding room between the river and the hills. Most extraordinary precautions have been taken to protect the permanent way from the action of the river, and at times [illegible]

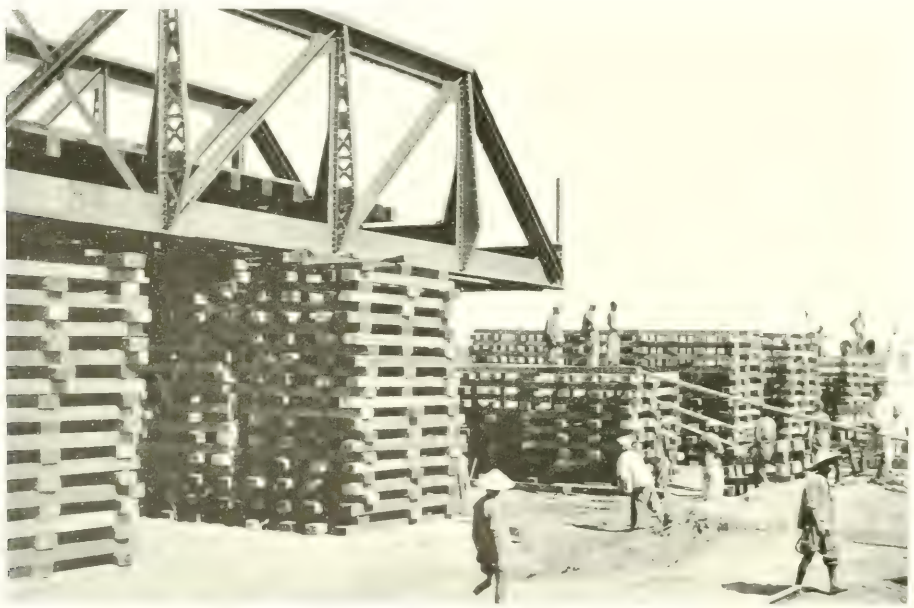
flood the valley is almost impassable. In these southern sections are to be found solid stone bridges of 1,400 feet, 300 feet and smaller, while steel bridges of 600 feet and smaller are fairly common. At Taschichou a branch line runs to Inkou and connects with the railway from Newchwang to Shanhaikwan and Peking.

At Nan-Santilipu the branch line to Port Arthur continues in the south-western direction, while the main line turns to the eastward and runs to Dalny on the shores of Dalienwan (Talienwan) Bay. Here the Russians have constructed a great city, a fitting terminus to so great a line.

POPULATION.

The country lying along the line from the Siberian Railway to Vladivostock is very sparsely populated, with the exception of two narrow belts on the Nonne and Sungari Rivers, each about 1,000 versts wide. On the whole length of this section there are only five towns—Hailar, Tsi-tsi-kar, Hu-lan-chen, Harbin, and Ninguta. These are chiefly administrative centres, and have little commercial importance. The whole district from the south of the Sungari River is, however, thickly settled. Near the line are situated fourteen towns which are trading and industrial centres, and many villages. The whole of this country is under cultivation. Only the district in the middle of the Liaotong Peninsula is not so populous. Near the southern sections of the line are coal mines worked for the railway under an English engineer, and connected with the main line by railway. The total length of the Southern Manchurian line from Harbin to Dalny, with branches, is 992 versts.

The line is well laid, and the solid stone stations give an air of stability to the whole railway. The railway guards are stationed every fifteen versts, and there are never less than twelve men in a post. As a civilising force the railway has done incalculable work, and when the through service of trains is properly organised it should be easily possible to travel from Paris to Dalny in fourteen to fifteen days.



METHOD OF CONSTRUCTING THE PERMANENT BRIDGES.

The spans are loaded [illegible] sleepers by hand into position on the permanent stone foundations, half the spans being placed into position from either bank of the river.

NOTES AND NEWS.

The s.s. "Grangesberg."

THIS vessel, lately built on the Wear, and intended for the shipment of iron ore from the Baltic to Rotterdam, should help to solve an important problem. Instead of taking a week or a fortnight to unload, as is the case in ordinary ships, she can clear her cargo in thirty hours. This is achieved by an ingenious equipment of derricks and a special arrangement of the hold. The fourteen masts are ranged on each side of the hatchways in two lines, and altogether support twenty-four derricks, so arranged that they can all be working together. The hold is divided into a like number of compartments, so that each derrick has a twenty-fourth part of the ship to unload. The masts can, if necessary, be used for sails. She has engines of 2,200 h.p., her contract speed being 10 knots an hour. The dimensions of the *Grangesberg* are: Length, 440 ft.; beam, 62 ft.; depth, 29 ft. She was built to the order of Messrs. W. H. Muller and Co. of Rotterdam, by Messrs. William Doxford and Sons, Ltd., of Sunderland, to whom we are indebted for the photograph.

King Edward VII. Bridge at Kew.

The new bridge at Kew, recently opened by His Majesty King Edward, not only makes adequate provision for the large increase of traffic, but adds twenty feet to the navigable waterway of the river. In 1892 the engineers, Sir John Wolfe Barry and Mr. C. A. Brereton, were instructed to examine and report on the advisability of widening and otherwise improving the bridge which has lately been removed. On investigation, however, it was ascertained that the foundations of the piers were not in a satisfactory condition, and, that it would be impracticable to attempt to improve the gradients. They therefore recommended the entire reconstruction of the bridge, either in stone or in steel, and after carefully considering all the circumstances of the case, and having regard to the cost of maintenance, the Councils decided to adopt the former.

The new bridge consists of three elliptical arches, the centre one being 133 ft. span, with a headway of 20 ft. above Trinity high water, and the two side openings being 116 ft. 6 in. span, with a headway of 17 ft.

The two piers are each 18 ft. thick at the level of the springing of the arches, increasing to 38 ft. at the foundations, which are carried down into the solid London clay at a depth of 18 ft. below the bed of the river. The navigable waterway of the river is 300 ft.

The width of the carriage way over the bridge and its approaches is 30 ft., and the footways on either side are 9 ft. 6 in. wide, making a total width of 55 ft. between the parapets and 57 ft. 9 in. from outside to outside of the bridge. The width of the footways on the approaches is increased [illegible]

A NEW DEPARTURE IN SHIPPING—THE S.S. "GRANGESBERG."

KING EDWARD VII. BRIDGE AT KEW.

of the roadway over the bridge and approaches is 1 in 40.

The foundations of the piers and abutments are laid with cement concrete, protected by whole timber sheet piling tongued and grooved, and at a sufficient depth to be out of the reach of scour, and also to admit of the bed of the river being hereafter deepened so as to give a navigable depth of 25 ft. below Trinity high water if required.

The whole of the arches and the exterior of the piers, abutments, and other portions of the bridge, and of the retaining walls of the approaches is of solid granite, obtained mainly from Cornwall and Aberdeen, some of the larger stones weighing as much as eight tons each.

A temporary bridge was commenced in March, 1899, and the traffic turned over it in October, 1899. The removal of the old bridge was then immediately commenced, and this work was sufficiently completed to enable the cofferdam for the piers of the new bridge to be begun in December, 1899.

The piers and abutments were then proceeded with, and the iron centres for the permanent stone arches were put in position. The masonry of the arches was commenced in May, 1902, and completed December of that year.

The engineers of the bridge were Sir John Wolfe Barry, K.C.B., and Mr. Cuthbert A. Brereton, M.Inst.C.E., their resident engineers being Mr. R. W. Dana, Assoc. M.Inst.C.E., and Mr. W. G. Wales, Assoc. M.Inst.C.E.

The contractors were Messrs. Easton Gibb and Son, of London, who have successfully carried out the work.

The accompanying photos are reproduced by the courtesy of Sir John Wolfe Barry and partners.

AN EARLY STAGE OF THE WORK.

THE NEW RUSSIAN BATTLESHIP "TSAREVITCH."

Displacement, [illegible] tons. 10,600 I.H.P. Speed, [illegible] knots. Launched, [illegible]

Armour Protection: The *Cesarevitch* has a complete belt, varying in thickness from 10½ in. The barbettes, which are hooded, are protected by 11 in. and the secondary turrets by 6 in. armour.

Principal Armament: Four 12 in., twelve 6 in. and [illegible] quick-firing [illegible]-calibre guns.

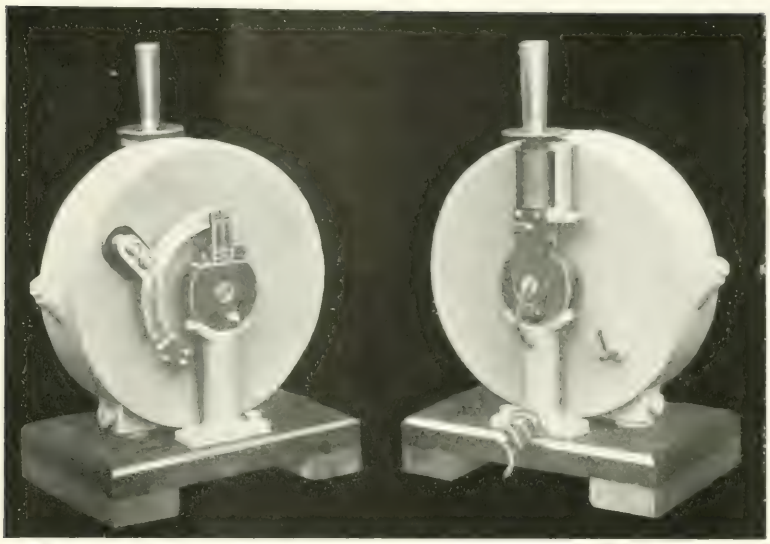
[By courtesy of the Royal United Service Institution.]

THE FRENCH FIRST-CLASS BATTLESHIP "ST. LOUIS."

Displacement, 11,275 tons. 14,500 I.H.P. Speed, 18 knots.

Armour Protection: Water-line Belt, 15·7 in., tapering to 10 in.; Upper Belt, 3 in.; Turret, 15·7 in.; Armoured Deck, 3·5 in.

Armament: Four 12 in. guns in turret, one forward and one aft; ten 5·5 in. quick-firing guns; twenty 3-pounder quick-firing guns; four 1-pounder quick-firing guns; and thirteen machine guns: with four torpedo-tubes (two submerged).



THE WOOLLISCROFT PATENT ENCLOSED STARTING SWITCH.

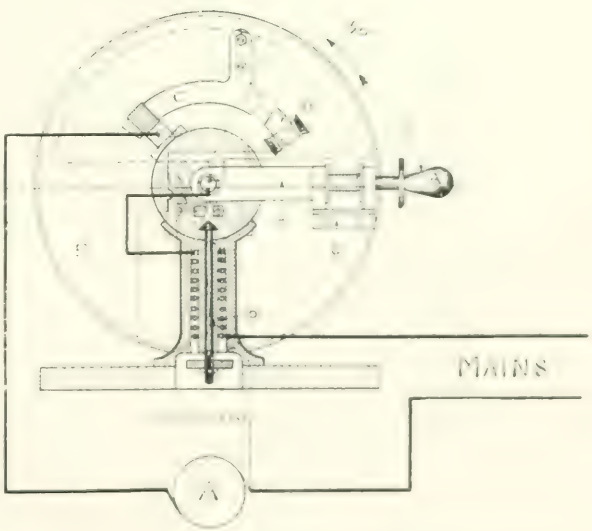
New Safety Enclosed Liquid Starting Resistance and Switch.

Mr. J. H. Woolliscroft, Chief Assistant Electrical Engineer of the Sandycroft Foundry Company, Ltd., Chester, has devised a novel motor starting switch, consisting of a watertight cast-iron drum partially filled with a solution of soda and water, and fitted with external contacts and terminals and internal electrodes. The drum is carried on insulating bearings, and has a screwed plug, which covers the aperture used for the introduction of the liquid, and also acts as a relief valve for the gas generated in electrolysis. Its action will be understood from the accompanying diagram of connections. The chief advantages claimed for the new switch are simplicity of construction, absolute reliability of action and freedom from sparking.

The company urge that liquid resistances are better than metallic ones for the gradual starting up of continuous and alternating current motors, and have only fallen into disuse through troubles which were thought to be insurmountable. Great trouble has been experienced in the past with liquid resistances of the open type, owing to the accumulation of dust, creeping of liquid, etc.; in the new switch this is impossible.

It can be fitted with maximum and minimum releases. The maximum is enclosed in one of the cast-iron standards, and in the event of an excessive current passing during the act of switching on or whilst running, short circuits the minimum coil, and allows the drum to return to the off position.

Switching on the armature before the field of motor is excited is impossible. The contact being of a sliding nature there is no tendency to prevent the switch readily returning to the off position (as experienced with multiple contact switches due to roughened surface by



A—Lever rotating on axis held by clip when in vertical position.

B—Cast-iron case containing liquid, on insulated bearings, and free to rotate 90 when picked up by retaining coil in series with the field.

C—Sliding contact fixed to internal blade, it rotates with B, but is insulated from it.

D—Maximum release protected inside cast-iron bearing pedestal.

E—Minimum release.

F—Level of liquid.

G—Retaining coil armature fixed to [illegible]

H—Short circuit contact fixed to B.

parking) when operated by the automatic release.

As there is no sparking or danger of [illegible] this switch is well adapted for gaseous or inflammable dust-laden places. Through being enclosed the evaporation is very slight, and only requires slight addition of water at long intervals. These switches are suitable for operating reversing motors, and also for polyphase work. It is also claimed for them that they require practically no attention, and can be easily moved without spilling or loss of liquid. In the following diagram of connections the switch is shown with circuit open and ready for starting a shunt motor. In stopping the motor, switch puts in all resistance before opening circuit.

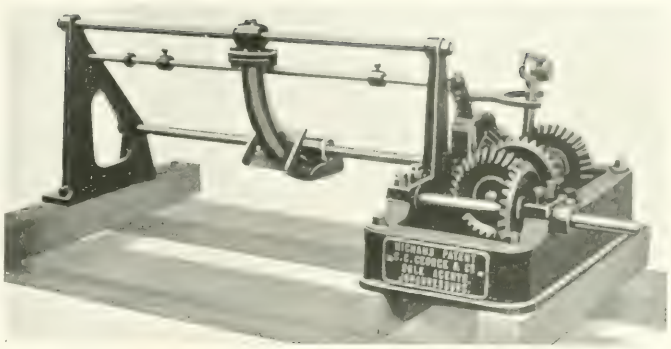
A 10-TON NILES CRANE, 40-FT. SPAN, RECENTLY INSTALLED BY THE NILES-BEMENT-POND COMPANY, U.S.A., OVER THE SHOP OF THE CROCKER-WHEELER COMPANY, AT AMPERE, N.J.

The girder of this crane consists of two built-up I-beams; this type of construction being employed for cranes of small capacity where the span is short.

Notes and News.

Iron and Steel Institute.

The autumn meeting of the Iron and Steel Institute, will be held at Barrow-in-Furness from Tuesday, September 1st to Friday, September 4th. The programme will include visits to the shipbuilding yards of Messrs. Vickers, Sons and Maxim, Ltd., the works of the Barrow Hematite Steel Company, Ltd, the British Chilled Iron and Steel Company, the Furness Railway Company, and the Millom and Askam Iron Company; also to the iron ore mines at Hodbarrow, and Messrs. Kennedy Bros.' mines. Excursions will be arranged to the Lake District and to Blackpool.



MR. J. HIGHAM'S NEW WET SAMPLER.

It is claimed that by this appliance the problem of automatic wet sampling has been satisfactorily solved. A full description by our Johannesburg correspondent will be found at page 57.

French Engineers in England.

A large party of French engineers, members of the Association des Ingénieurs des Ponts et Chaussées et des Mines, and all connected with either railways or public works in France, came over to this country in the early part of June for the purpose of inspecting various large undertakings of interest to them. They visited the Surrey Docks, were shown over the Tower Bridge, where the various engineering details were fully explained to them, and, subsequently, under the guidance of Mr. C. L. Morgan, chief engineer of the London, Brighton, and South Coast Railway Company, they inspected the extensions which that company are carrying out with a view to improving the approaches and increasing the accommodation at Victoria Station. The visitors also inspected the works of the Baker Street and Waterloo and the Great Northern, Piccadilly, and Brompton Railways, now in course of construction. Some of them descended at the Thames Embankment shaft of the Baker Street and Waterloo line in order to proceed by means of an electric engine and trolleys to Oxford Street, the laying of the tube for the new line having now been completed except for a distance of about half a mile. The remainder of the party, after a passing glance at the surface works in Trafalgar Square, drove to Oxford Street, where they descended the shaft at that point, and, joining the first section, saw the process of tunnelling as carried out with the help of the Greathead shield. From Oxford Street the visitors drove to the site of the future station of the Great Northern, Piccadilly, and Brompton Railway, in Sloane Street. There another descent was made, and the party, after walking about half a mile through the tube, as already constructed, reached the present terminus of the tunnelling, where a rotary excavator was seen in operation. The party next drove to Shepherd's Bush, to inspect the generating station of the Central London Railway. On the 10th inst. the visitors proceeded to Liverpool to see the Docks, the Overhead Railway, and the Manchester Ship Canal.

The Junior Institution of Engineers.

This society, continuing its useful programme of visits to works, arranged for an inspection on the 24th ult. of Messrs. Spiers and Pond's Model Laundries, Art Dyeing and Chemical Cleaning and Steam-Carpet Beating departments at Battersea. On the 29th ult. a visit was paid to Messrs. John Bennett, Lawes and Co.'s Atlas Works at Millwall.

The Institution of Electrical Engineers.

The Council has awarded the following premiums for papers and communications:—The Institution Premium, value £25, to Dr. J. A. Fleming, F.R.S., for his paper entitled "Photometry of Electric Lamps"; the Paris Electrical Exhibition Premium, value £10, to Mr. M. B. Field, for his paper entitled "A Study of the Phenomenon of Resonance in Electric Circuits by the Aid of Oscillograms"; two Extra Premiums, value £10 each, one to Messrs. A. D. Constable and E. Fawssett jointly, for their paper entitled "Distribution Losses in Electric Supply Systems"; and the other to Dr. W. M. Thornton, for his paper entitled "Experiments on Synchronous Converters"; an Original Communication Premium, value £10, to Messrs. A. Russell and C. C. Paterson, for their communication entitled "Sparking in Switches." The Council has awarded Salomons Scholarships, value £50 each, to Mr. G. B. Dyke, of University College, London; and to Mr. H. W. Kefford, of the Central Technical College. The award of the David Hughes Scholarship, value £50, has this year been made to Mr. W. H. Wilson, of King's College, London.

Business and Professional.

Mr. William C. Grant, who is well known in London as an expert on all matters appertaining to office organisation, has accepted the position of Manager of the Card Index Department of the Trading and Manufacturing Company, Ltd., specialists in office equipments, etc., of Chapel Place, Holborn, E.C.

Bath Electric Tramways.

Satisfactory progress is being made with the Bath Electric Tramway Scheme.

The generating station equipment is to consist of three 200-kilowatt Westinghouse compound wound generators, direct connected to Yates and Thom horizontal, tandem, compound engines, running at a speed of 100 revolutions per minute, and one 75-kilowatt compound wound, Westinghouse generator, direct connected to a Westinghouse compound steam engine to operate at a speed of 300 revolutions per minute. Two 15-kilowatt negative boosters are to be supplied, with a 12-panel switchboard, of the Westinghouse tramway type.

The boiler house is to be equipped with three 10,000 lb. Babcock and Wilcox straight tube, water-tube boilers, and a Clay Cross economiser; surface condensers are to be used, and also a complete equipment of water softening and grease separating apparatus.

The car shed is to have a capacity for forty double deck, 56-passenger cars. On the second floor and across the front of the car shed are to be located the offices of the company.

The rolling stock is to consist of forty cars, the bodies and trucks being of the Milnes make, and the equipments the Westinghouse No. 40B.90. Most of the cars will have the Westinghouse Magnetic brake.

The Engineering Conference.

The Engineering Conference, organised by the Institution of Civil Engineers, was preceded on the 16th ult., by the delivery of the "James Forrest" lecture by Mr. W. H. Maw, who indicated some of the directions in which the further aid of the physicist is more immediately required by the engineer. Consideration was first given to the economical generation and distribution of power. The lecturer remarked that water power being limited in this country, we are practically dependent on some form of heat-engine. It, therefore, behoves us to secure in such engines the highest possible degree of economy. "Highest economy" to the physicist will mean the most complete utilisation of heat supplied to the engine; to the user it means the highest return on money expended. It is the duty of the engineer to secure the latter result, which, in some cases, may be secured by avoiding refinements rather than by adopting them. But, in order to judge, the engineer must possess accurate knowledge as to the heat economies which it is possible to secure by the adoption of certain special systems and the cost of carrying them out in practice. It is only when heat "economy values" are accurately known that their commercial economy can be properly estimated.

Not many years ago the only heat engines in use on a large scale were steam engines. Now an important share of work is done by internal combustion engines, and each year this share is becoming greater, although the steam engine still enormously outnumbers all other prime movers. During the past ten or fifteen years the average efficiency of steam engines has materially increased, but finality has not been reached.

Professor Unwin, in 1895, gave an account of the accepted theories as to the action of steam in an engine; but he was careful to point out that, whereas, on the theoretical considerations alone, the use of steam jackets round engine cylinders might be expected to afford beneficial results (in checking condensation of steam in the engine cylinder), yet in some cases it was a negligible quantity. The causes for this are to a great extent known in general terms, but quantitatively our knowledge is far from that exact kind which is of real scientific value. This is reflected in the practice of leading steam engine builders; there being a divergence in practice which it is impossible to reconcile with the possession of adequate experimental data.

Another important problem relating to the steam engine is the economic effect of interheaters through which the steam is passed from one cylinder to another in a compound engine. The data on which the use of such heaters is founded are far from being of a satisfactory character, and present discrepancies which require clearing up. The practice of superheating steam also presents certain problems which are far from being satisfactorily solved. It is nearly half a century since Hirn carried out his historical experiments, and the trials made since are legion; but those which have a direct bearing on advanced practice are comparatively few, and by no means complete in character. A great defect is that experiments with superheated steam have been carried out on engines designed to work with ordinary saturated steam. To determine the full economic value superheated steam must be used in engines specially constructed for its use both as regards materials and design.

We are also much in want of a thorough determination of the physical properties of superheated steam extending over the range of temperature likely to be employed. Equally desirable is the thorough investigation of both saturated and superheated steam in various types of turbine motors, a matter of rapidly growing importance. Referring to the question of higher steam pressures, Mr. Maw stated that the problem requires investigation, but the prospect of any very material increase of economy being obtained does not appear particularly hopeful. We are also without any direct termination of the latent heat, volume, and temperature corresponding to pressure in cases of steam pressures exceeding 350 lb. per square inch. The published data obtained by extrapolation are by no means strictly to be relied upon.

Altogether, the steam engine still affords ample field for experimental research, and such researches must differ widely from ordinary so-called engine trials, and must be carried out by appliances quite unknown to early experimenters. Very experimental engines in various engineering colleges would be admirably adapted for the purpose. There should be co-operation between the various colleges, and the organisation should be such that different lines of research should be followed, so as to enable each institution to carry out that definite part of the work for which its equipment is best adapted. The mere aggregation of a large mass of data is far from being all that is needed. What is equally necessary is the thorough discussion of such data, the determination of the strong and weak points, and the extraction of such lessons as the facts afford.

In the course of his remarks on the subject of internal combustion engines, the lecturer remarked that much that he had stated regarding the steam engine applied also to the various types which were now assuming such an important position amongst modern motors. In the latter part of his lecture, Mr. Maw pointed out the many unsolved problems in constructional engineering that remain for the civil engineers to attack. He remarked that the growth of electrical engineering constitutes a great object-lesson, sufficient in itself abundantly to emphasise the fact that the future progress of engineering is indissolubly bound up with the progress of physical research.

A selection of the papers read at the Conference will be found in another part of the Magazine.

OUR BIOGRAPHY OF THE MONTH.

MR. CUTHBERT ARTHUR BRERETON, M.Inst.C.E.

THE name of Mr. Cuthbert Arthur Brereton, M.Inst.C.E., has been lately prominent in connection with the opening of the new bridge at Kew. He was responsible, with his partner, Sir John Wolfe Barry, K.C.B., for the engineering of the entire scheme from its inception. Mr. Brereton has also been connected with a number of important railway and dock enterprises. Youngest son of the late Mr. John Brereton, of Brinton, Norfolk, he was born in 1850. He married in 1880, Frances Ann Caroline, only daughter of the late Captain Birt Wyndham Rous Jenner, of Wenvoe, Glamorganshire. He was educated at Clifton College, and subsequently obtained a Whitworth Exhibition and diplomas of the Science and Art Department, South Kensington, in geometry, magnetism and electricity, acoustics, light and heat, and machine construction and drawing. He decided upon the profession of a civil engineer, becoming a pupil of the late Mr. R. P. Brereton, of Westminster. From 1870 to 1871 he was engaged as assistant engineer on the construction of the Fermoy and Lismore Railway. His first important appointment was that of resident engineer to the Llynvi and Ogmore Railways and Porthcawl Docks in South Wales (1872-76). From 1876 to 1879 he was executive engineer of the Waterford, Dungarvan, and Lismore Railway; and from 1881 to 1884 he was connected with the Lewes and East Grinstead Railway, and the City Lines, Inner Circle Railway, as assistant engineer to Sir John Wolfe Barry, K.C.B. His partnership with Sir John dates from 1893. Mr. Brereton has since been engaged in the construction of the Barry Docks and Railways, Middlesbrough Docks, Surrey Commercial Docks, and Kew Bridge; also in various works for the Natal Government, the Caledonian Railway Company, the North Eastern Railway Company, the Barry Railway Company, the Metropolitan Railway Company, the Metropolitan District Railway Company, and the Alexandra (Newport) Dock and Railway Company. At the present time he acts as engineer of the Whitechapel and Bow Railway and the western section of the Great Northern, Piccadilly, and Brompton (Tube) Railway. He is a lieut.-colonel of the Engineer and Railway Volunteer Staff Corps, Member of the Council of the Institution of Civil Engineers, and Associate of the Institution of Naval Architects. His connection with the Institution of Civil Engineers dates from 1880, when he was elected a member, and he became an associate of the Institute of Naval Architects in 1886. Mr. Brereton resides at Twickenham, and interests himself in many of the local affairs. He is a commissioner and trustee of Richmond Bridge, and has for some years been churchwarden and trustee of St. Stephen's, East Twickenham. He is a manager and trustee of the schools of that parish, and a local representative of the Hampton Rural Deanal Conference. Mr. Brereton is an ardent sportsman, and devotes [illegible] and fishing.

Photo by Gunn and Stuart, Richmond.

MR. CUTHBERT ARTHUR BRERETON, M.INST.C.E.

WORKSHOP PRACTICE.

A RÉSUMÉ OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

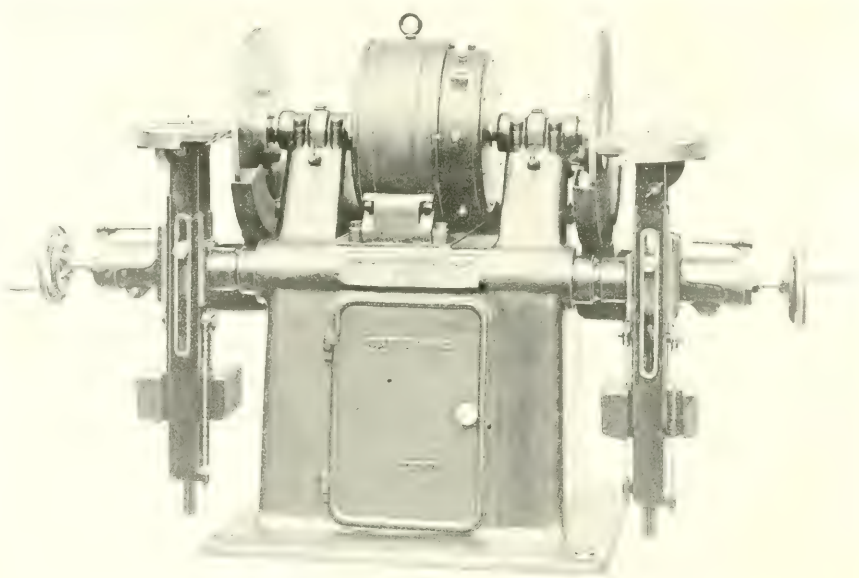
AN ELECTRICALLY DRIVEN DISC GRINDER.

IN our issue of October last we noticed a new disc grinder brought out by Messrs. C. W. Burton Griffiths and Co., of Ludgate Square, E.C. This firm has now added a motor drive to the machine. Our illustration shows the 20-in. size, but either of their disc grinders can be fitted similarly. The motor is entirely enclosed, and is of the four-pole type, measuring 8 in. by 3 in. Any possible endlong movement of the grinding discs due to expansion through heat is guarded against, so that the micrometer readings are not affected. This motor drive makes the machine a self-contained one, so that it may be located anywhere regardless of the proximity of overhead beams or ceilings, and it may also be moved about from place to place if necessary, so long as a rigid foundation is secured.

UP-TO-DATE WORKS.

The new works of the Shannon, Ltd., at Dalston, London, embody much that is up-to-date and interesting. This firm employs a large number of woodworking machines in the manufacture of office fittings for its card system, and letter filing, etc. Much of this machinery is of American manufacture. It is operated by electricity, derived from dynamos, direct coupled to Belliss and Morcom high-speed engines of 480 h.p., the steam being produced by water tube boilers by Babcock and Wilcox. An elaborate system of exhaust pipes brings every particle of sawdust and chips from the machines to the boilers, where it is burnt as fuel. The sweepings of the floors are sent down through floor valves to the stoke hole, to be also consumed in the boilers. Grinnell sprinklers serve every floor. A pure cool atmosphere is thus maintained.

There is no unnecessary handling of materials in the shops. All materials come in at the front entrance, which is closed at night by a revolving iron shutter. An electric lift elevates the stuff to the different floors, and this is governed in such a way that it is impossible to start the lift while any of the doors remain open. Trolleys serve each floor. The employees are provided with lavatories, shower baths being fitted on each floor, as well as private bathrooms. There is a dining-room for the use of employees whose homes are distant, and altogether these works are a remarkable improvement on some of the old cabinet shops we are acquainted with.



NEW MOTOR DRIVEN DISC GRINDER.

THE NEW WORKS OF THE SHANNON, LTD.

HIGH SPEED STEELS.

Although high speed steels are becoming familiar, the results obtained by their employment still afford room for astonishment. The high speeds, combined with coarse feeds, and the quantity of chips removed in a given time, "knock the bottom out of" the old-time ideas. Better results are obtained on forgings than on cast iron, which is more or less hard. The cutting speeds for wrought iron and soft steel used to be taken at from 20 to 25 feet per minute. Speeds may now range from 50 to 200 feet, varying with the depth of cut, and feed. A more striking figure perhaps is the weight of metal removed in chips, which has sometimes reached 500 to over 1,000 lb. in an hour. What a number of problems now confront the tool maker! What becomes, too, of the laboured work of the smith in bringing forgings down nearly to size, in order to save the labour and time of the machinist? A good deal of heavy forged work will go the way of light forgings, which have been displaced so greatly by the hollow spindle lathe, turning from plain bars. The lathes of ten years hence will, it is safe to predict, have to be greatly modified on present-day designs in order to enable them to stand up to the new tool steels. Formerly the lathe governed the pace of cutting; now the tool steel imposes its conditions on the lathe. The difference in the power required is well illustrated by a statement by the General Electric Company of Schenectady, to this effect: In the case of two 26-in. lathes, one doing heavy work, the other light, one requires a 25 h.p. motor, the other a 5 h.p. motor. The first was roughing steel shafting at a speed of 100 feet per minute, with a $\frac{3}{8}$th cut, and an $\frac{1}{8}$th feed; the second was used for finishing light cast-iron work at a maximum cutting speed of about 75 feet per minute, $\frac{1}{8}$th in. cut, and $\frac{1}{16}$ in. feed.

With the more extended use of high-speed steels, the old light lathes must be to a great extent displaced. The time will come when more than the mere height of centres will be demanded in giving dimensions of lathes; the size of spindles, the weight of the lathe, with certain details of design, and guarantees of accuracy will have to be included. These details will make the difference in prices of some lathes of the same nominal size, double, and even treble that charged for others.

SYSTEMS IN SHOPS.

There is no more remarkable sign of the times, industrially speaking, than the substitution of system for the personal control of works, and the problems

that arise out of wages payment. There is a perfect invasion of our shops going on by the American card systems, which is absolutely astonishing. The contrast between the new and the old in this respect is very puzzling. Recently an advocate of card systems spoke very deprecatingly to the writer about a firm in which single orders costing several thousand pounds each involved scarcely any clerical work. Knowing the methods of that firm well, we are of opinion that it gets along just as well in its present system as it could with the most up-to-date card filing methods. Nearly all the work done is massive; there is little repetition, and the control is wholly of a personal character. That is an exceptional case. In the larger number of works the card system can unquestionably be used with economic result.

HIGH AND LOW WAGES.

The opinion is too common that the growth of labour-saving devices and systems mean reductions in wages bills, or in the substitution of low-paid men for highly-paid ones. This is only true to a limited extent, and in certain departments. What they mean is increased production, which is a different thing from low wages. It is the height of folly to entrust high-class tools to clumsy, careless men. Valuable gear cutting machines, high class milling machines, and tool room equipments generally should be in the hands of superior men in receipt of higher wages. The premium system, like that of piece work, can only prove successful so long as men carry away extra wages on Saturdays. Even the machines which employ unskilled labour will only be operated to their full limits when heavy balances are being made. The slightest movement towards lowering wages is a wet blanket on operatives, as is natural in human nature.

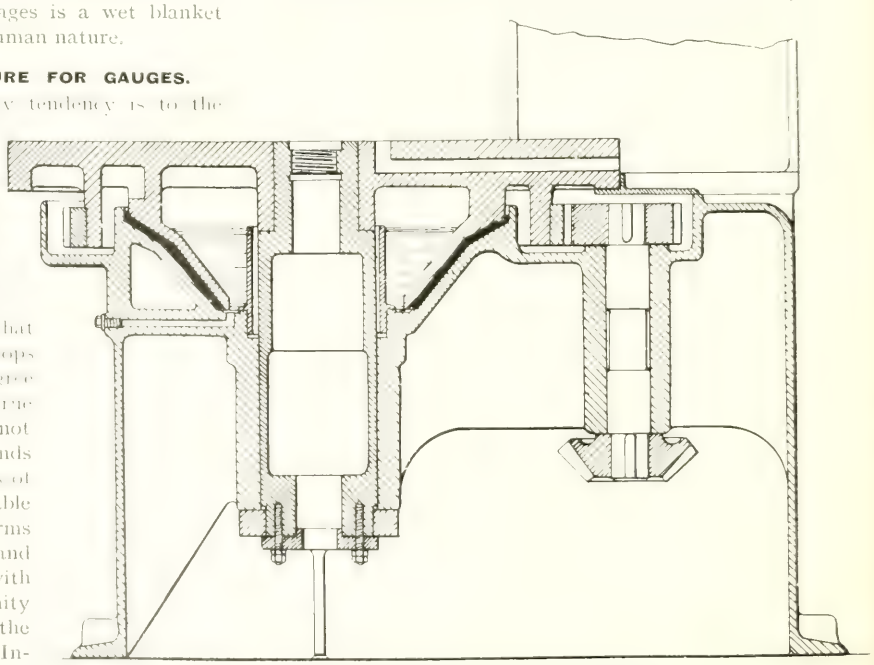
A STANDARD TEMPERATURE FOR GAUGES.

Since the obvious present-day tendency is to the substitution of gauged for rule measurement, the temperature at which these gauges are standard has not received the attention which it merits. When gauges are purchased, no statement is made as to the temperature at which they are of correct dimensions. It is considered that alterations in temperature in shops affect the work in the same degree as the gauges. Though this is true as regards similar metals, it is not so with materials of different kinds which have different co-efficients of expansion. It is also desirable that gauges made by different firms should be standardised at one and the same temperature. It is with a view to obtain this uniformity that the French society for the Encouragement of National Industry is endeavouring to induce manufacturers to accept tentatively a temperature of 15 degrees cent. (59 degrees fahr.) as a standard at which gauges are to be measured.

IMPROVED BORING MILL.

The increasing use of the boring and turning mills in engineers' shops is having the result of producing modifications in their designs in the hands of different makers. We illustrate a section through the table of the heavy 40-in. and 30-in. mills of the Anglo-American Machine Tool Company, of Laurence Pountney Hill, E.C., the leading feature in which is the submergence of the annular wearing surfaces in a bath of oil. A double cone takes the place of the "Schiele" curve—the ideal form for the spindle bearings, being more readily tooled and practically as good. The bearing surface consists of white metal (shown by the black part in the drawing) divided into eight sections with channels through which the oil circulates freely. The height of the oil at any time is indicated in a pipe at the side of the machine. The oil can be drawn off when dirty, by removing a screw plug at the front.

The drawing indicates the table drive by spur wheel and pinion, and the cover over the latter can be removed for examining the gear. The pinion drive takes place just below the tool bar, with the result that the side thrust on the table and spindle is less than if the pinion were located elsewhere. This arrangement, with the oil bath, permits of high speeds and heavy cutting on the machine. In another design of machine, used chiefly for turning, and not for boring, the spindle is simpler, the table being driven by a worm and a wheel hobbed on the edge of the table ring. This table runs on a flat face, the worm and wheel only



SECTION OF IMPROVED BORING MILL.

running in a bath of oil. The end thrust of the worm is taken on rollers. In both these designs the spindles are hollow (see figure), so that cuttings fall through to the floor inside the frame, whence they are readily removed. The spindles of all machines are threaded internally near the top, to permit of the use of clamping bolts for holding pieces for finishing operations. Central mandrels also can be screwed in, for centering some classes of work, thus saving tentative setting.

A feature of these mills of single column type is that the table is placed to one side of the column, instead of directly in front. This has the effect of lessening the overhang of the tool, and it also brings the stress of heavy outside cutting against the main column, instead of tangentially thereto.

The feeds of these machines have been operated by a friction disc until the present year, but a newly patented arrangement of positive feeds is being substituted at the present time in some of the sizes made. The gears are enclosed in a box, and changes are effected by shifting a lever which moves an index indicating the rates of feed on a dial. The feeds per revolution of the table are $\frac{1}{16}$ in., $\frac{1}{8}$ in., $\frac{1}{4}$ in., $\frac{1}{2}$ in., $\frac{1}{4}$ in., $\frac{1}{2}$ in., $\frac{3}{4}$ in., 1 in. The old friction disc feeds are retained for the present in some machines, but the positive ones are being fitted to a large number of those specially for the high-speed cutting steels.

GIRL LABOUR IN ENGINEERS' WORKS.

Objection has been made to this practice, but on no solid grounds. Whatever objections may be urged against it in engineers' works would apply equally, and often with far greater force, to the factories in which such labour has been adopted as a matter of course for a generation, or a century past. The occupations in which girls find a suitable sphere are light core making, the taking charge of light machine tools, light fitting at the vice, the minute and more delicate adjustments of small portions of mechanism, in the inspection of gauged work of a light character, in some branches of electrical work, in French polishing, etc. We have seen them engaged in all these occupations, and, with rare exceptions, seated at their tasks. The surroundings of modern engineers' shops are more sanitary and healthful than those in the older class of weaving and spinning sheds and shops, and immensely superior to sweating dens, and to those of average domestic service. The separation of the sexes in different rooms should, however, be insisted on and a retiring room provided, as is done in some of the best works. Under such suitable regulations, girl labour in engineering works has come to stay, and is not objectionable.

STANDARDISATION IN ELECTRICAL CRANE WORK.

This department of practice has become more thoroughly standardised than the practice of the general crane makers ever has been. This is one of the minor advantages due to the use of electricity, of which no account is taken, but it is one that will be highly appreciated in course of time. This is due in the first place to the building of motors in certain types and sizes, whence all the rest of the crane equipment as controllers, switches, collectors, etc., follow. No such precise data were ever available in the older power cranes as are in the electrical. Nobody ever knew the horse power of a crane. The only test was the lifting of the load with a margin, the latter being very elastic, and varying from zero to 100 per cent. Now you get a motor of a definite capacity, adapted to a crane output of a definite horse power, and every other connection is similarly standardised. Electrical crane work is thus becoming even more cut and dried than that of the steam and hydraulic cranes has been.

ANALYSIS OF MOULDING SAND.

The following is a rough method of analysis of moulding sand which has been furnished to the trade by the Garden City Sand Company, of Chicago: Heat to dryness and pulverise in a mortar; weigh out a specific quantity, say one gram. Boil with concentrated nitric acid until the sand is white. Filter, dry and weigh; number of centigrams is percentage of silica. Precipitate iron in filtrate with sodium hydrate. Filter, dry and weigh; this gives iron. Precipitate alumina in filtrate with ammonium hydrate. Filter, dry and weigh, as before. In each instance number of centigrams gives percentage of substance present in the sand. The presence of lime or magnesia can be demonstrated by dropping a little hydrochloric acid on the sand. Unless the sand bubbles noticeably there is not sufficient of either to injure the sand.

THE CONTINUOUS SYSTEM.

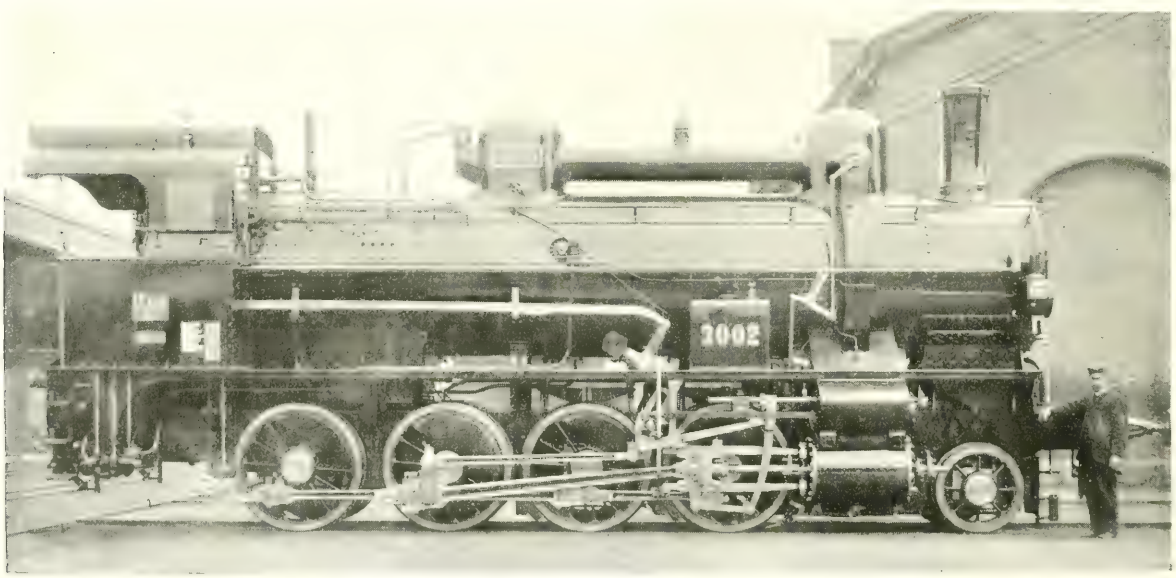
Dr. Richard Moldenke, an American expert in foundry matters, advocates strongly the continuous system of working in foundries as the best means of meeting labour difficulties, the competition of "our chief competitor" Germany, and the only way of salvation which many foundrymen must arrange for, or "go out of business." Personally, he says he "always enjoyed the sight of floor upon floor of moulds ready to pour the first thing in the morning."

We hope that the time when systematic night work, with two or three shifts of men is far distant. It is bad enough to adopt at a push, but the conditions would be most unwholesome for industry as a whole. To sleep by day and work by artificial light is necessary in the case of some men, but an extension of such a system to industry in general is to be discouraged. The American foundry industry must be hard put to when continuous pouring is seriously considered. English foundrymen are not anxious to go in for that [illegible]

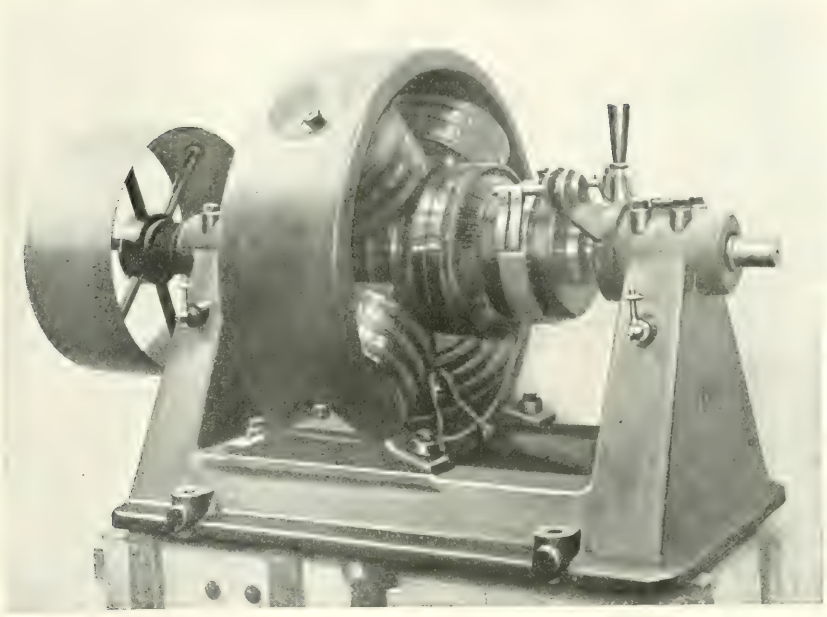
SOME RECENT PUBLICATIONS

"THE LOCOMOTIVE OF TO-DAY."
Second Edition. The Locomotive Publishing Company, Ltd. 180 pp. 2s. 6d.

THIS excellent little work, whose author's name is not given, is a most valuable treatise in brief upon the salient features of modern locomotive practice. Its subject is dealt with in five different sections, namely: (1) the Boiler; (2) the Engine; (3) the Framing, Wheels, etc.; (4) the Tender, Brakes, etc.; while Section 5 gives prominent examples from modern practice. All the parts and details of modern British railway engines are described with admirable terseness and lucidity, and the "Reason Why" in respect of the various differences in design and construction that are still met with in locomotives, and which seem no nearer than ever toward arriving at anything approximating to uniformity, are explained with much clearness. Additional value is given to the book by its wealth of illustration. There are sixteen extremely good half-tone plates showing examples of the most modern engines, one specimen each from America, Belgium, Austria, and Switzerland being added to the twelve British examples. Then there are thirty-seven figures showing various locomotive details, and three working drawings and one of Mr. Ivatt's Great Northern coupled express engines. Altogether "The Locomotive of To-day" is a handy manual that any student of locomotive engineering cannot afford to be without, while it possesses much interest for the amateur as well as for the professional reader.



EIGHT-COUPLED COMPOUND ENGINE USED ON AUSTRIAN SOUTHERN RAILWAY.
From "The Locomotive of To-day."



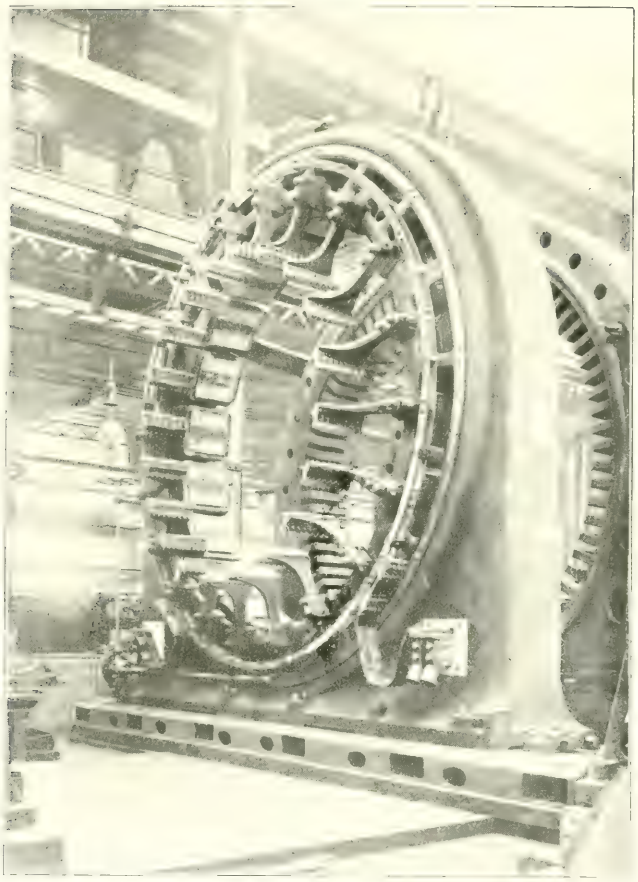
HIGH VOLTAGE DYNAMO, OF BROWN, BOVERI AND CO.
From "Design of Dynamos," by Professor S. P. Thompson, D.Sc., F.R.S.

"DESIGN OF DYNAMOS."

By Silvanus P. Thompson, D.Sc., F.R.S. E. and F. N. Spon, Ltd. 12s.

CONFINED to continuous current generators, this work is not intended to supersede the more complete handbooks on the special branch of electrical engineering of which this is only a part, but it is primarily designed, the author tells us, for his own stu dents Among the requisites in the designer who is to produce machines that will hold their own in the competition of to-day, Professor Thompson includes, "a grasp of principles, electrical and mechanical ; a knowledge of machinery and its construction ; an acquaintance with the successful forms that exist, and a perception of the reasons why they are successful." Emphasis is laid upon the fact that mere rules will not make the successful designer of dynamos. The section devoted to armature winding schemes is admirably illustrated by plates printed in colour, and a number of valuable folding plates and appendices are bound up with the volume in addition to numerous illustrations. Owing to its completeness and the extreme care with which the facts are presented, Professor Thompson's work cannot fail to be largely in request among the designers of electrical machinery. The specially interesting machine for high voltage, by Brown, Boveri and Co., illustrated herewith, is included among many other useful examples of dynamo design, and is thus described :—

In this small machine, working at high pressure, great care is bestowed upon the question of insulation throughout the design. The chief data of this machine are as follows: Outside diameter of yoke, 35 in. ; length parallel to shaft 11·4 in., of cast steel. The magnet-cores are circular in section, having a diameter of 7½ in., and the cores, and at the same time the pole-pieces, are attached to the yoke of the machine by a single steel bolt ; the fact that the seatings, both at the yoke and pole-pieces are turned, and thus possess a rounded surface, making this possible. The armature is 15 in. in diameter, the length between core-heads being 9·85 in. There are 59 slots and 1,416 conductors ; there being thus 24 conductors per slot, arranged in the slots in two taped sets of 12 conductors each. Round wire of a section of 0·0037 square inch bare, and 0·0070 square inch insulated is used, and the total thickness of insulation between conductors and core amounts to 0·07 in. The winding has a two-circuit series parallel grouping ; and throughout great attention is given to the insulation of the end turns and connections. But the design of the commutator is the most noteworthy feature of this machine. Owing to the fact that only 20 amperes have to be collected, the question of insulation was the paramount one to be considered. There are 177 segments, or 3 per slot ; the end clamping plates of this commutator are unusually substantial. Mica 0·035 in. thick is used between the segments, and the end insulating rings project far beyond the end of the segments, and are not turned off flush, as is usually the case with machines of lower voltage. On the whole the construction is very simple ; that of the commutator especially so ; the design being very open throughout, and such that there is little chance of dust or dirt collecting, which might lead to a breakdown in the insulation.



BRUSH GEAR OF A LARGE TRACTION GENERATOR, BY THE BRITISH WESTINGHOUSE COMPANY.

From "Continuous Current Dynamos and Motors, and their Control."

"CONTINUOUS CURRENT DYNAMOS AND MOTORS, AND THEIR CONTROL."

By W. R. Kelsey, B.Sc., A.I.E.E., F.Ph.S. The Technical Publishing Company, Ltd. 5s. net.

MR. KELSEY here completes a useful volume, which consists largely of articles reprinted from *The Practical Engineer*. It is remarked that probably in years to come we shall see dynamos and motors designed and made in engineering workshops quite as freely as steam engines are to-day. The elements of dynamo and motor design are clearly set forth, and their practical construction is dealt with concurrently. The latter part of the work is devoted to their working and practical application to lighting, the transmission of power, etc. Electrical traction receives a considerable share of attention, so far as tramway motors and their gear are concerned, and another feature in which the volume differs from similar works is the discussion of the flux-speed-torque curves for motors excited by the different standard methods.

"CASSELL'S POPULAR SCIENCE."

With numerous plates and illustrations in the text. Published in monthly parts, at 7d. net. Cassell and Co., Ltd.

WE imagine that there are few readers, however blasé, who could handle these numbers without becoming interested in many of the subjects dealt with. The illustrations are admirably done, and the text affords recreative reading of a high order. "Cassell's Popular Science" has also a high educational value: the nine or ten parts we have seen reflecting considerable credit upon editor and publishers alike.

"WIRELESS TELEGRAPHY AND TELEPHONY."

Compiled by Dr. Maurice Ernst. Illustrated. "Electricity" Office, 36, Maiden Lane, Covent Garden, Strand, W.C. 1s.

THIS little book sets forth chiefly the advantages of the Orling-Armstrong system, following a general introduction, and we think the title might, with advantage, be a little more specific. However, the "man in the street" will find here some particulars of a most interesting phase of wireless telegraphy, and if it serves to remind him that aetheric telegraphy is neither the work of one man nor confined to a single system, so much the better. There are twelve illustrations, and a bibliography is added for the benefit of those who require further information on the subject.

THE LAYING OUT OF ENGINEERS' WORKSHOPS

BY

JOSEPH HORNER.

This article is concerned with the floors, tracks, and windows of engineering buildings. Previous articles dealt with General Conditions (March, 1903), the Separate Units comprised in an Engineer's Works (April), Ground Plans (May), Walls and Roofs (June). The series is illustrated by typical examples.—ED.

V.

THE FLOORS.

THE floors in works are variously constructed. Board is suitable for pattern and machine shops; earth and clinker is usually laid down in the boiler shop, smithy, and heavy erecting shops, and sand in the foundry. In machine and light erecting shops located on the ground floor, earth is not infrequently employed. Cobbles, granite sets, or flat paving are, however, probably most common. The latter make a sound durable floor, though, if the stones are of large size they become fractured in the course of time through the dumping down of heavy work upon them. Cobbles, therefore, are better—the same style as used for street paving—but lumpy; the stones should be practically flat. Stone floors are dry, and nearly free from dust; earth floors are not. The paving of a large shop is expensive, and for this reason earth and broken stone has so often been used in the past. For the boiler shop and smithy an earth floor is not objectionable. Generally, cinders, clinkers, or ashes are laid on the dirt, and rammed in, so that a good floor is secured at low cost. The sand floor for the foundry is practically universal, the few exceptions occurring in some shops where plate moulding alone is done on benches. The depth of sand laid down ranges from about 2 ft. to 4 ft. in foundries.

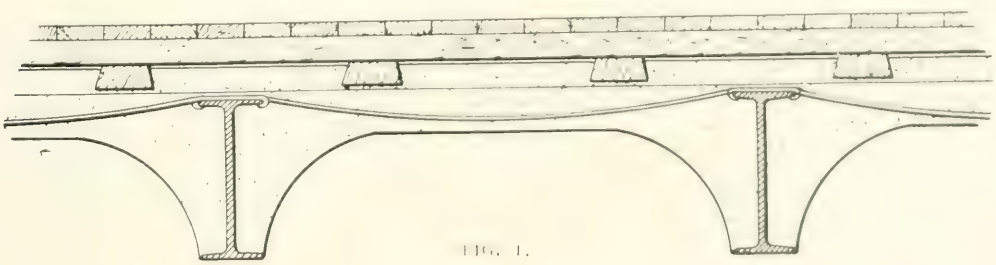


FIG. 1.

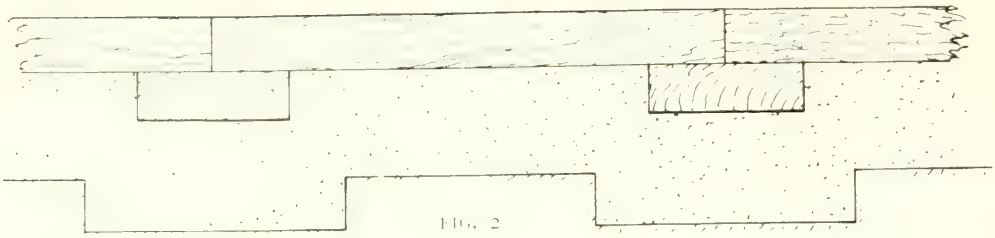


FIG. 2

THE CASE OF BOARD FLOORS.

The objection to laying down wood in machine shops on ground floors is that the massive work handled damages the boards, and also that the men's boots, moving about constantly next to lathes and machines, wear the boards hollow locally. In the course of time, therefore, portions of the floor have to be relaid. A board floor also interferes with the putting in of foundations for new machines, but earth or paving stones do not. This objection has considerable weight in an expanding shop, since it is clearly impossible to say what alterations in, or additions to, the equipment of machine tools may be wanted in the course of a few years. This, however, does not apply to the light machine shops, where bolting down can be done directly to the floor, or into the joists beneath. For heavy machine shops, therefore, there is much in favour of floors laid with paving stones in flags of moderate dimensions and good substantial thickness, or in granite sets. Or, a good concrete is an excellent substitute, but it *must* be good, otherwise, in the course of time, it will become broken up into powder. For light shops, whether on ground floors or in galleries, a board flooring is best.

A slight objection to boarded floors in machine shops is the absorption of oil by them. This may be largely prevented by standing or suspending waste oil trays in those spots where drippings may occur. But if a close-grained wood, such as maple, is chosen for the flooring boards, less oil will be absorbed than by deals.

CONCRETE FLOORS.

Concrete has been used for shop floors on a suitable foundation of broken stone. The foundry floor of the Walker and Pratt stove-making works, at Watertown, Mass., may be instanced. In this foundry there is a central gangway set $1\frac{1}{2}$ in. lower than the floor, and sharply separated therefrom by a bar edging set in the concrete. This, however, is a foundry where the work is mostly flat, and turned over, and sufficient sand for this is stocked on the floor.

COMPOSITE FLOORS.

Concrete, steel, and timber are variously employed in ground floors. Fig. 1 shows one of these, composed of cement concrete, surrounding steel joists. Pine sleepers of dovetail section are embedded in the concrete, so that they cannot rise. These have 2-in. pine planks tongued and grooved, nailed to them, and to these $\frac{7}{8}$-in. maple boards, 3 in. to 4 in. wide are nailed.

Ashes enter into the composition of many floors. Fig. 2 shows one in which a bed of tarred ashes supports timber cross bearers

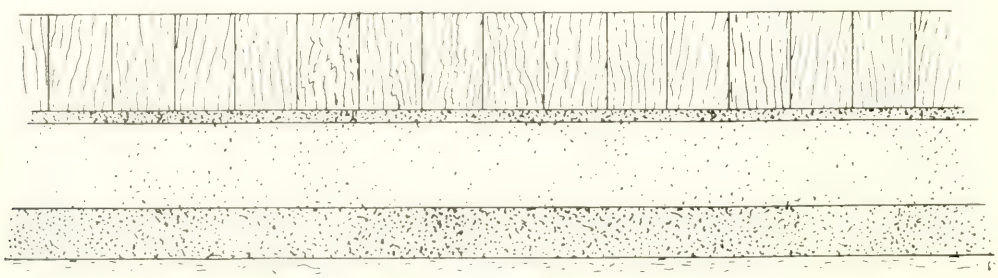


FIG. 3.

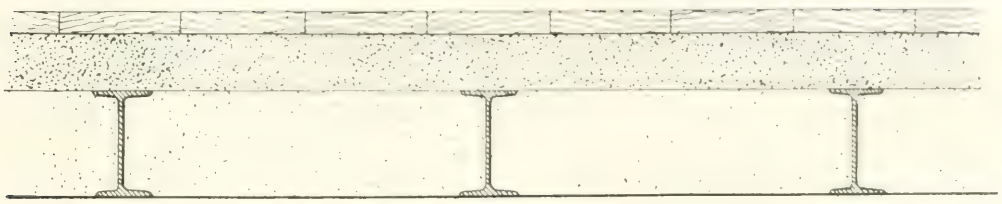


FIG. 4.

embedded at intervals of 3 ft. to 4 ft., creosoted, or coated with tar and pitch, and covered with $2\frac{1}{2}$-in. or 3-in. planks. Fig. 3 illustrates a floor in which a bed of concrete is carried on ashes well rammed. Over this a thin layer of sand receives the wood blocks, laid on end, run in with pitch. In another style, a layer of rubble concrete carries a thickness of asphalt, which again sustains a layer of coke breeze concrete, to which thick planks are spiked.

GALLERY FLOORS.

Gallery floors are built differently from ground floors, being supported on joists of timber, or of steel. But concrete frequently enters into the composition of these, to enable them better to absorb the vibrations of machine tools, and render them less liable to suffer from risk of fire. Fig. 4 illustrates a floor supported on steel joists embedded in concrete, and sustaining a thickness of coke breeze concrete, on which the boards are spiked. A better plan is to nail the boards on timber sleepers embedded in the concrete, as in fig. 5. A solid but rather expensive type of gallery floor is shown in fig. 6, in which deal joists are laid close together and covered with boards. In the Westinghouse works at Manchester the floors of the machine galleries are built in this style, on 2-in. by 10-in. boards, laid edgewise against one another and spiked together. A very solid rigid floor is thus ensured.

THE TRACKS.

These, after cranes, are the most important element in the economical handling of work, and the heavier the work done in a firm the more essential is it that tracks should be fully utilised. It is often easier to move heavy castings and forgings along level tracks than to hoist and carry them by the cranes, which may be more profitably employed in actual lifting. It is impossible without tracks to maintain a connection between departments. Considering the advantages of tracks it is very remarkable that appreciation of them has been of so slow growth, and that it is but partial yet. Some firms have not got beyond the high road stage of transit. You see half-a-dozen labourers, their bodies in nearly horizontal positions, tugging and pushing at trolleys over the rough sand of a foundry floor, when a couple of men would have done the work easily in a fourth the time with tracks. In like fashion the

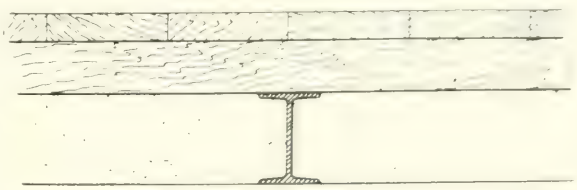


FIG. 5.

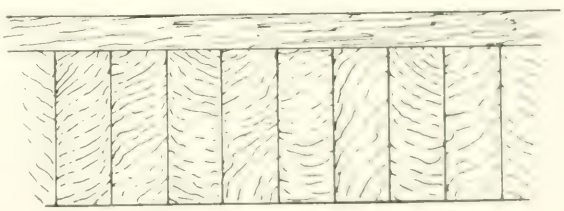


FIG. 6.

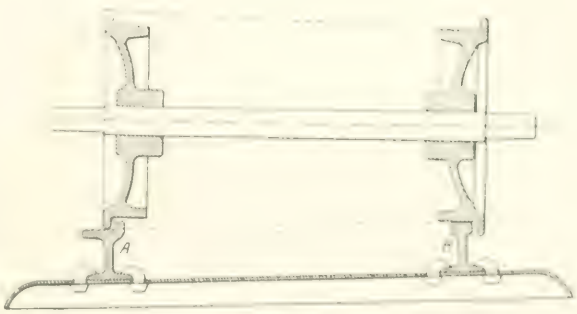


FIG. 7.

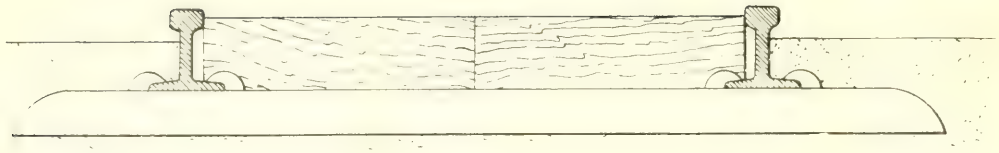


FIG. 8.

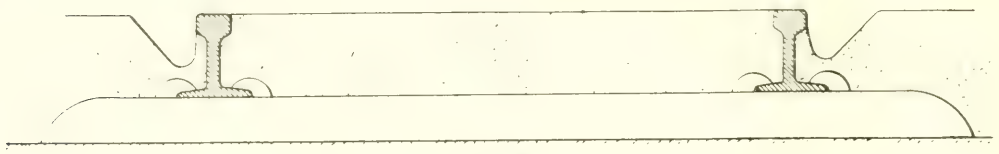


FIG. 9.

trolleys are dragged over cobbles in the machine shop, or over dirt floors, and about the yard from shop to shop. The cost of a regular system of tramways, with turntables and switches, would be recouped in such shops in a couple of years or less.

In shops doing light work, and especially in storied buildings, the place of tracks is taken by hand barrows with two wheels, instead of one. These can be run along the floors and in and out among the machines with forgings and castings, or boxes of small pieces, about as readily as though tracks were laid down. But they are unsuitable for heavy machine shops, turneries, and foundries, and for yards.

Objection has sometimes been made to this system of communication that it occupies floor area in the shops which might be utilised for work. There is not much in this, because the main tracks always go down the centre, which must be left unoccupied in any case, in an orderly shop. In shops where all is "at sixes and sevens," work is dumped down anywhere, and one has to pick one's way among a wilderness of iron and steel. This is the old style. Branch tracks again must be left clear, but with proper prearrangement these can be so located as to occupy ground that would be of little value; and the advantages of tracks, turntables, and switches far outweighs any slight loss of ground area so occupied.

The value of shop tracks is not measured alone by the convenient connections they make between shops separated by distance, but also by the difference between the tractive force that has to be exerted in each system. A wheelbarrow does not seem so very wasteful of labour and time in shops where labourers are present in force, and where, too, considerable quantities of work are carried about by hand. Such shops still constitute a large majority. But it is only necessary to consider for a moment to see the utter waste of such a thing. It is equivalent to the substitution of stage coaches for express trains, of carrier's vans for goods trains. It means resistance to traction of

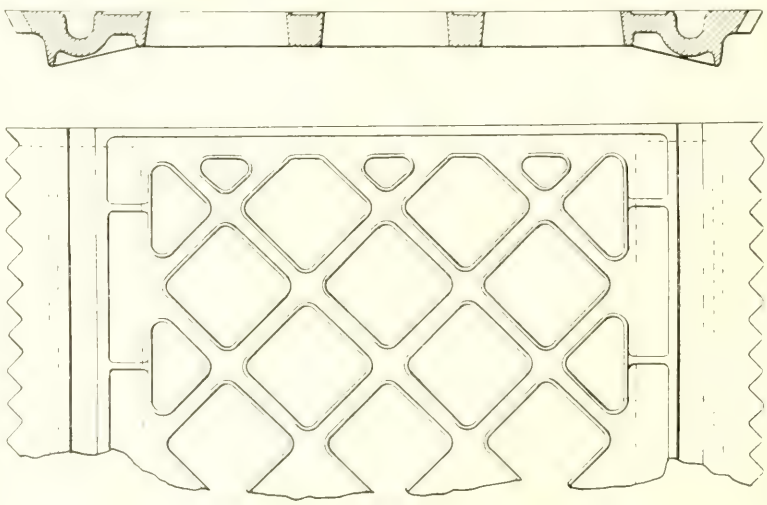


FIG. 10.

perhaps $\frac{1}{50}$ against $\frac{1}{250}$. From actual trials Mr. J. W. White has shown the following: That with a portable railway, say of 2-ft.

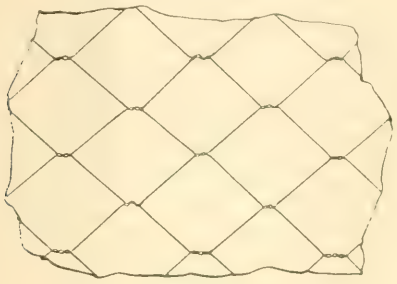


FIG. 11.

gauge, and tipping equilibrium trucks, a man will easily take 20 cubic feet of earth a distance of 200 yards, tip it, and return with the empty truck inside of five minutes; whilst a man with wheelbarrow and planks would require an hour to do the same work. These facts are equally applicable to workshops. When locomotives are substituted for human traction in large shops the system is complete. Such is the case at Crewe, Horwich, Woolwich, and many other large works.

In order to fully utilise these tracks, no obstructions must be permitted to render a detour necessary. Straight lines and short cuts must be rigidly adhered to in laying out the shops. Central offices, flanked by shops to right and left give an imposing façade, according to architect's ideas, but it is not economical to divide the shops by a group of offices.

Only the best is good enough for narrow gauge lines in shops. A firm bedding for the rails is most essential, because they are liable to sink and become uneven owing to the overhang sideways of the heavy loads which they have to carry—conditions which do not obtain in permanent way. Heavy rails are desirable, bedded on transverse steel sleepers in preference to using wooden ones. Mr. White gives it as a rule for the weight of rails that twelve times the greatest load on one wheel in tons gives the weight in pounds per yard of rail.

Some large works are served with two systems of tracks, one of standard, and one of narrow gauge. The value of the first named consists mainly in the facilities which it affords for loading materials and work in connection with the railway that serves the works, and also for bringing in large quantities of raw material, and coal, etc., so saving a second unloading. The narrow gauge is used chiefly for the service of the shops, because it is more economical of space, and the trucks used are amply large enough for the temporary character of their loading. It would be outrageous to have full-sized railway trucks blocking up the shop areas in the transit of work in course of progress. Nearly all the stuff that has to be handled can be loaded in trucks running on 18-in. to 24-in. gauge tracks. The important point to secure is the strength of the truck, and the firm bedding of the permanent way.

The diversion of materials and work into shop bays, and between shops, is done both by turntables and curves. When practicable, the latter are much to be preferred, being less expensive and more rapid in service than turntables. A radius of 12 ft., measured to the centre of the rail, is a minimum for curves where the trucks are moved by hand. Twenty to twenty-five feet is much better if it can be arranged.

The objection to curves is the super-elevation of the outer wheel, and the sliding friction which is caused by the employment of rigid axles. Curves are laid down in shops without super-elevation of the outer rail, and therefore radial axles should be employed. Rigid axles are, however, commonly employed, and friction is lessened frequently by making one or both wheels loose on an axle. Rigid axles and fixed wheels cause friction by the sliding of the wheels through a distance equal to the difference in the length of the inner and outer rails, and by the outer wheel flanges thrusting the treads of the wheels inwards, with consequent extra friction of the treads and of their flanges against the rails.

FIG. 12.

In the C. W. Hunt system, which is very extensively employed, the axles are made radial, the wheel flanges are placed on the outsides of the wheels, and provision is made by an outer

curved rail, A (fig. 7), for the outer wheels to mount, and run on their flanges when going round the curve, the inner one remaining on its tread. The object is to make the flange of the outer, and the tread of the inner wheel parts of a cone, whose apex is the centre of the curve. This is illustrated in fig. 7. The rail, A, is therefore only used for the outer curve, the inner one, B, is like the ordinary straight sections of rail.

These rails are made by the C. W. Hunt Company in 20-foot sections, riveted on steel sleepers (fig. 7), ready for laying down on any kind of floor. Figs. 8 and 9 illustrate the system for outside flanged wheels and steel sleepers applied to any ordinary floor, and to one of concrete respectively. In the first case the space between the rails is filled with timber, in the second with concrete, this being laid flush with the top of the rails, the necessary space for the flanges being left in the concrete. This flush style of laying is much to be preferred in shops, as presenting no obstructions, but for the yard it does not matter so much. The curved sections are made in lengths fastened to sleepers ready to lay down. So are the switches, which are made with the extra rail on the outer curve to permit the flange of the wheel to run up instead of on the tread. The points are pushed by the labourer's foot, but switch stands are supplied if preferred. The turntables run on rings of hardened steel balls.

Another style of track is made by this firm, of cast iron wholly, rails and connecting plates being solidly cast in one. This is cast in sections five feet long.

Fig. 10 illustrates an excellent cast iron track which is laid down at the Lincoln Engine Works, Chesterfield, to the design of Mr. Clench. Instead of using a solid plated connection, an open grid design is adopted. In this nothing stands above the shop floor, the grooves for the wheel flanges being sunk in the casting. The corrugations on the outer edges are formed in order to maintain the tracks firmly in the concrete in which they are embedded, and particularly to obviate endlong movement.

WEIGHBRIDGE PITS.

Provision has to be made in the ground areas in the lines of the tracks for weighing goods in and out. This should be foreseen in laying out the plans, otherwise the weighbridge pits may run foul of pipes and conduits. Where material comes into works, or into a department of works, and where finished work is sent out, there a weighbridge should be fixed. In some cases, as, for example, when the materials and work are light enough to be carried by hand, or tipped from a light truck, the platform weighing machines, either fixed or portable, are best. These, however, are specially suitable for use on floors, where they divide favour with others which are sunk in flush with the floors. These,

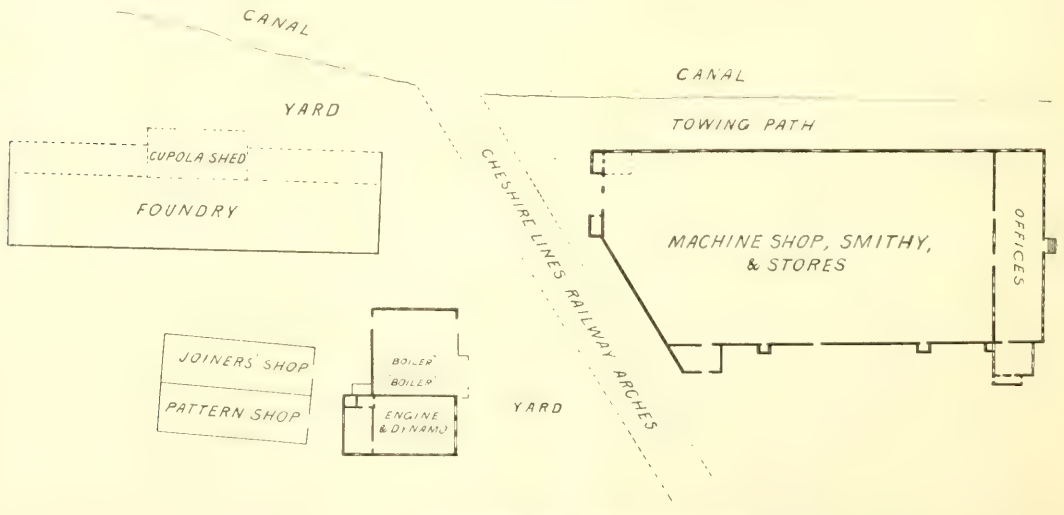


FIG. 13.

and the similar bigger machines that are fixed outside, opposite entrance gates, must be located during the progress of the building. The older weighbridges were built in brick lined pits. Cast iron framings are now supplied ready to go into place, saving time, and generally at less expense than brickwork. These framings are also very handy when weighbridges have to be let in flush in warehouse floors.

GLASS.

The builders of some of the old works must have imagined that the less glass there is in a shop the better. It is difficult to see any reason for this, beyond the risk that glass runs of being fractured by flying chips, stone throwing, and other mishaps, and mischief. Actually, as much glass ought to be put into a building as the structural strength of the design will permit, and that is a very great deal. High walls, and dwarf windows are an anomaly. So are large roofs with small skylights. A safe canon is to insert windows as high as practicable in walls, and as close together as will permit of ample constructional strength in the steel, or masonry between, and to run skylights along nearly, or quite the entire length of the roof. In a shop laid out on such lines, there need be no sacrifice of strength and stability, while the interior, to the remotest corners, is flooded with light, even in winter time. The difference in the bills for artificial light in such a shop, and in one scantily supplied with windows, will be enormous for the year.

Sometimes enough is not made of end walls, where the main entrance door, or doors, are placed. Tall windows flanking the doors, and shallow windows above are always practicable in tall shops of even moderate span. The gabled ends of a row of such buildings have also a harmonious and pleasing appearance as a works frontage.

The sash frames for the roof lights, as well as those in the walls, are often made of cast iron. There is nothing to be said against these, if they are designed properly ; that is, if they are so proportioned as to shrink equally in cooling ; and when in place they seldom fracture. Timber can be used if preferred, but as the dimensions required in factories are not stock sizes, they involve expensive joinery. Perhaps timber looks better than iron, and certainly it admits of prettier designs with larger variations in the cross sections of frames and bars, with heavy and light mouldings adjacent, than iron does. For this reason it may be preferred for the end, or side windows of large dimensions in walls. But nothing of the kind is required in roof lights. Here plain sash bars and frames are used. These may be made of timber. But timber and cast iron are being run closely by wrought steel frames, and sash bars. These are made in all conceivable sections and designs. They harmonise well with the steel built shop, they are light, are unaffected by weather, and are not liable to fracture.

The glass in factory buildings is specially liable to fracture, and the renewal of broken glass becomes a big item in large works. Covering it with wire netting is only a partial protection, besides interfering with the periodical cleaning of the glass. There is a glass made with wire insertion (fig. 11), which lessens the risk of fracture, and also increases the light in a shop by the refractions from the prismatic edges (see the section, fig. 12), which face inside the building, with the nearly horizontal edge upwards. There are two kinds, one without wire, the other wired, the latter preventing the glass from falling in case of fracture. The price is rather high, but the advantages are obvious and great. The Westinghouse works are glazed with this refrax glass.

Direct sunlight is bad in offices, and when unavoidable, blinds must be requisitioned. This difficulty can be got over in another way by the use of ribbed glass. This, of course, shuts out the view from the windows, but the objection may sometimes have compensations.

In the artificial lighting of shops which have ceilings, and of drawing offices, the inverted type of arc lamp is to be preferred to direct light. If the ceiling is painted white with a faint tinge of green, a soft diffused light is thrown down on the shops, and shadows are practically absent.

THE NEW MELDRUM WORKS.

In concluding this article, we have to go back a little to the subject that was discussed in the third article of this series—the ground plans of shops. We should have included a notice of

the new Manchester shops there, but the firm were not prepared at the moment to supply the plan, which is now given in fig. 13.

The old shops of Messrs. Meldrum Bros., Ltd., in Manchester, occupied the various floors of a most awkwardly shaped storied building, in the basement of which one of the present partners commenced the experimental work whence the furnace business has grown to such a phenomenal extent. About two years ago the firm realised the absolute impossibility of continuing in that location, hemmed in by streets and warehouses, and with no facilities for making castings, and they bought a piece of ground at Timperley, eight miles away, in nearly open country, and about a mile and a half from Broadheath. The area is well served by the canal, and railway, but the ground is divided into three portions by railway arches and a roadway, the latter, not shown, being at the left hand of the figure, and beyond it there is also a strip of land, not shown, available for future extensions. In some respects it would have been well if a continuous rectangular strip of ground had been available, but the proximity of railways and the canal was a great counterbalancing advantage. Under the circumstances a separation of the machine shops, etc., from the foundry was unavoidable, but communication is made through the arches of the Cheshire lines. Another advantage lies in the large yard area surrounding the shops, available for storage, and for extensions. The offices are at one end, facing the Timperley station. These are three stories high, and they include the drawing offices. The plan arrangements were adopted as the result of the lengthy consideration of alternative designs.

Some features of these works may be noticed later. For the present it is enough to state the following facts. The new shops will be thoroughly up to date in all respects. Standard and narrow gauge tracks will traverse yard and shops, the sidings connecting to the Manchester, South Junction and Altrincham Railway, while the Bridgwater Canal serves the other side of the works. The shops are built on the one floor system. Electricity supplies both light and power. The machines are arranged in groups, each group having its own motor, in standard 12 b.h.p. sizes, capable of taking 25 per cent. overload. The difficulty due to the interference of line shafts with travellers is got over by fixing the line shafting about eight feet above the floor, thence driving upwards to the countershafts, which have their bearings on the crane girders. The crossing of the bays by belts is thus avoided.

The power-house has two Cornish boilers, 28 ft. by 6 ft. 6 in., with 3-ft. 3-in. flues, working at 160 lb. Alley and Maclellan enclosed engines are direct coupled to the dynamos. The foundry which is not yet completed, will have heavy and light departments. It will do a considerable amount of plate moulding, and will include a chemical laboratory.

The water supply of the works is obtained from two tube wells, the location and yield of which, it is interesting to note, were determined by the divining rod. It is pumped into a storage tank 60 ft. above the ground, whence it is conveyed by a system of underground piping all over the works.

THE NEW SOUTH AFRICA AND THE RAILWAY PROBLEM.

By our Johannesburg Correspondent.

Deals with the location and scope of the railway extensions approved at the Johannesburg Conference, and shows what is considered necessary to link up the various centres of production in the new colonies.—Ed.

ONE of the first duties to be undertaken in South Africa upon the conclusion of hostilities has been the reorganisation and extension of the railways. The recent conference on the subject held at Johannesburg, was attended by delegates representing the most important commercial, agricultural, and industrial interests of the Transvaal and Orange River Colony, and by representatives of the two Governments. As announced in a previous issue of Page's Magazine, the immediate construction of no less than seven new lines was approved.

In his opening speech to the Conference, Lord Milner explained that henceforth the railways of the two colonies will be run as one system, under one management, and with a common revenue and expenditure. Any net profit, after full provision has been allowed for maintenance and betterment, will be applied in the first instance, to meet any common expenses of the two colonies, and any further surplus that may remain will then be divided between the separate exchequers.

There is no doubt that this arrangement will make for efficiency in working the lines, and it will also remove some causes of political irritation, which has often resulted in South Africa from the perhaps natural desire of some of the colonies to considerably increase their revenue by heavy freight charges on goods passing through their territory.

FUNDS AVAILABLE FOR EXTENSION.

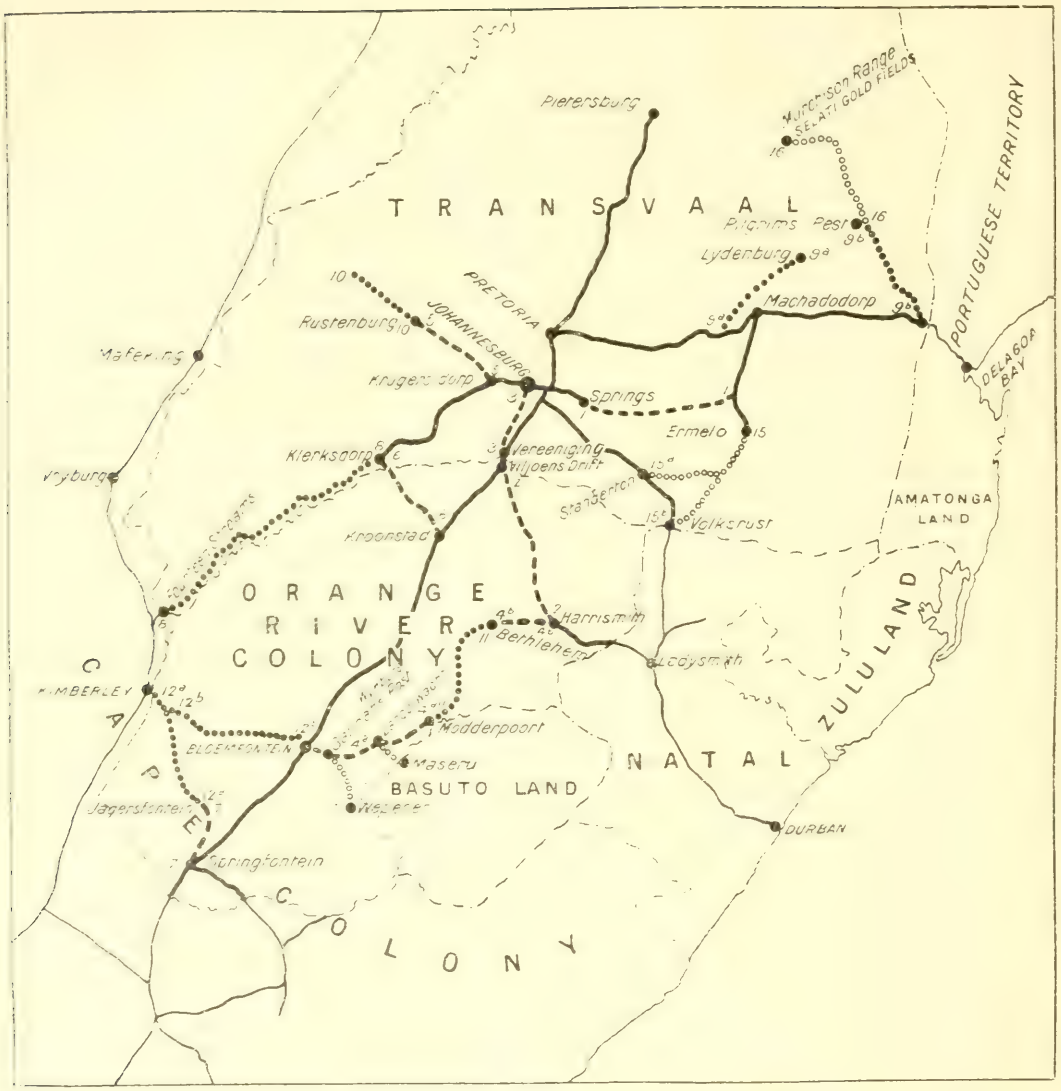
Out of the guaranteed joint loan of £35,000,000 to the the new colonies, it has been decided, subject to the approval of the Imperial Parliament, that a sum of at least £5,000,000 is to be set apart for railway extension. Lord Milner also stated that at the present time, twice this amount could be advantageously spent in thoroughly sound schemes of extension. Therefore, the conference had to consider in the first place, which of the many proposals should be immediately taken in hand by the railway management ; and, secondly, whether private enterprise should be encouraged in the construction of other lines, and, if so, under what conditions. This latter proposal has been approved, and if sufficient inducement is offered for the investment of private, capital in this direction, it may be reasonably expected that at least £10,000,000 altogether will be expended in new lines and rolling stock in the course of the next two or three years.

IMPROVEMENT OF MAIN LINES.

Before the war the main lines from Cape Colony, Natal, and Delagoa Bay carried 60,000 tons of goods per month into the Transvaal and the Orange Free State. At the present time, with some difficulty, the same lines are carrying over 100,000 tons per month, and it is confidently expected that this amount of traffic will be exceeded in the near future.

Sir Percy Girouard, the Commissioner of Railways stated that the maximum carrying capacity of a single line is attained when the crossing places are four miles apart, and that he proposed to bring the main line through the Orange River Colony up to this standard, and also to relay the whole of it with 80 lb. rails. With this improvement, and the use of 125-ton locomotives for the portion south of Bloemfontein, where the grades are 1 in 80, he considers that this line will meet any demands made upon it.

To ease the traffic on the present line from Natal through Volksrust, he proposed to provide an alternative route with much easier grades, by connecting Harrismith with Viljoen's Drift by a line along the Wilge River. This proposal was approved by the Conference. The eastern line from Delagoa Bay also requires relief, because between Middelburg and Pretoria [illegible] monthly of load traffic is picked up. This consists



Existing lines outside the New Colonies ... .

Existing lines in Transvaal and Orange River Colony ... ...

Lines selected by Conference for immediate construction with available funds ..

Proposed lines urgently required and open to private enterprise... ... ...

Other important lines which may be constructed by private enterprise... ... ...

Boundaries of Colonies ... ...

chiefly of coal for the Rand mines, and is likely to increase very considerably. The Commissioner proposes to give this relief by the construction of a new line from Springs to Ermelo, where it will connect to a private company's line which extends to Machadodorp on the main line from Delagoa Bay. This would form a loop line, presumably, for the through traffic, and thus leave the existing line chiefly for local transport. This proposal has been approved by the Conference, subject to the completion of a satisfactory arrangement with the private company above mentioned.

The construction of the new line from Harrismith to Viljoen's Drift will bring part of the Natal traffic into the existing main line from the Cape ports to Pretoria and Johannesburg at Vereeniging, and to avoid the congestion which would ensue it has been therefore decided

to build a new line from Vereeniging direct to Johannesburg, with a goods station on the West of the Rand, and sidings for delivery of coal on the mines.

INTERNAL LINES.

Of these, perhaps the most important is the so-called "Grain line," the significance of which is expressed in the words of the following resolution: "That this Conference accepts the principle that a railway from Bloemfontein *via* Modderpoort, Ficksburg, and Bethlehem, to a point on the proposed Wilge River Line, in the neighbourhood of Harrismith, is necessary for the development of the eastern districts of the Orange River Colony, and approves the completion of the railways from Bloemfontein to Modderpoort and Harrismith to Bethlehem . . ." It will be seen from the accompanying map that this resolution only provides for the immediate construction of the two ends of the proposed railway, but it is also to be noted that the one portion connects this grain district with Bloemfontein, and the other portion with Johannesburg, thereby opening up the two principal markets for food stuffs. Thus the agricultural as well as the mining interests have received consideration.

A number of other internal lines were considered, but, owing to the limitation of available funds, only three of these could be adopted, as given in the tabulated summary below :—

SUMMARY OF LINES APPROVED FOR IMMEDIATE CONSTRUCTION.

Route	Miles	Cost per mile including £ for rolling stock.	Estimated total cost.
		£	£
1. Springs to Junction on Ermelo-Machadodorp private line	137	6,840	937,000
2. Viljoen's Drift to Mile 10 on Harrismith-Bethlehem line	175	7,600	1,330,000
3. Vereeniging-Johannesburg and Rand Coal line . .	88	8,400	740,000
4. Bloemfontein-Johannesburg Grain line—			
(*a*) Bloemfontein-Modderpoort	84	6,500	546,000
(*b*) Harrismith-Bethlehem . .	65	6,300	410,000
5. Pretoria or Krugersdorp to Rustenburg (sum allocated)			500,000
6. Klerksdorp-Kroonstad	69	6,500	448,000
7. Springfontein-Jagersfontein ...	50	5,000	250,000
			£5,161,000

SCOPE FOR PRIVATE ENTERPRISE.

Although the above list provides for the expenditure of all the available public money, it by no means exhausts the possibility of profitable extension, and the Conference stated that the following lines are also urgently required.

8. Klerksdorp to Fourteen Streams, thereby connecting with the Bechuanaland line at Kimberley.

9*a*. Line connecting Delagoa Bay line with Lydenburg, or

9*b*. Line connecting Delagoa Bay with Pilgrim's Rest.

10. Extension of Rustenburg line through the Marico district.

11. Line from Modderpoort to Bethlehem, thereby completing the "Grain line" above mentioned.

12*a*. Extension of Jagersfontein line to Kimberley, or

12*b*. As an alternative, a line from Bloemfontein to Kimberley.

Only the want of Government funds prevents the immediate construction of the above lines, and the Conference has recommended that "every effort should be made to obtain the construction of these lines by private enterprise"

OTHER IMPORTANT PROPOSALS.

The following third list of proposed lines was also drawn up by the Conference, as being of great importance to their respective districts, with the recommendation that endeavours should be made to obtain suitable offers for their construction by private enterprise :—

13. Sannah's Post to Wepener.

14. Maseru to Langerwacht, *via* Lenmo River Mills.

15*a*. Ermelo to Standerton, or alternatively.

15*b*. Ermelo to Volksrust.

16. A line connecting the Murchison Goldfields with one of the existing lines.

CONDITIONS FOR PRIVATE CONSTRUCTION.

In order that the Government might not be hampered in dealing with offers for railway construction, the Conference did not attempt to lay down any hard and fast conditions, but merely recommended the observance of the following general principles :—

1. Right of Government to expropriate.

2. Government control of tariffs.

3. Government control of construction cost.

4. Profit to contractors to be determined without regard to share capital, and, as far as possible, either in relation to profit earned on working, or as a fixed percentage on outlay.

A NEW WET SAMPLER.

BY

EDGAR SMART, A.M.I.C.E.

It is claimed that the problem of automatic wet sampling has been satisfactorily solved by a new sampler, invented by Mr. J. Higham, the Cyanide Manager of the City and Suburban Company of Johannesburg. This is now described at length, and is illustrated with special drawings.—ED.

THE common practice of hand sampling the pulp from wet crushing mills by catching the whole flow in a dish for a few seconds at regular intervals, gives very accurate results if the intervals are short and the sampling is continued for a sufficiently long period, but it is a very tedious process, and wastes a lot of the operator's time. Therefore, many devices have been introduced from time to time for doing this work automatically. Figs. 1 and 2 illustrate diagrammatically the general principle upon which such automatic samplers have usually been constructed, although, of course, there has been much variation in detail. A water cistern, *a*, pivoted at *b*, is attached by rod, *c*, to the upper end of a lever frame, *d*, which can turn on the pin, *e*. At the lower end of this lever is a pipe, *f*, having a longitudinal slot, *g*. A balance weight, *h*, hangs on cord, *i*, which passes over the pulley, *k*, and is attached to the top of the lever frame, *d*, at point *o* in fig. 2. The pulp which is to be sampled flows along the launder, *l*, in the direction of the arrow, and falls over the end of it, as shown at *p*. The action of the apparatus is as follows :—

Water is supplied by the small pipe, *m*, so that the cistern slowly fills until it is sufficiently heavy to overbalance the weight, *h*. It then falls over and brings all the moving parts of the apparatus with it into the positions indicated by the dotted lines in fig. 1. It will thus be seen that the slotted pipe, *f*, passes completely

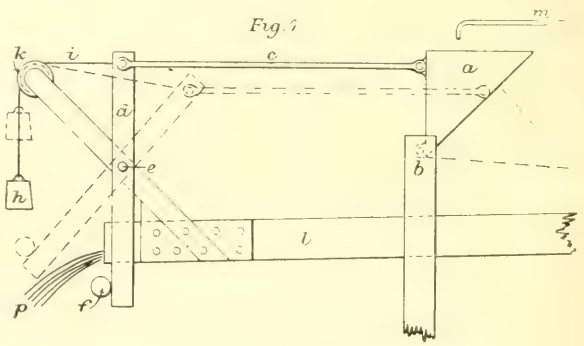


Fig. 1.

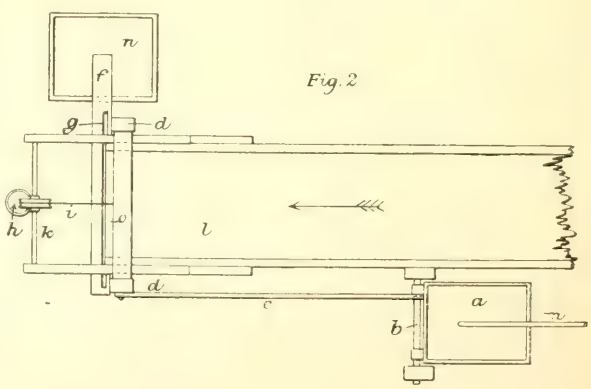
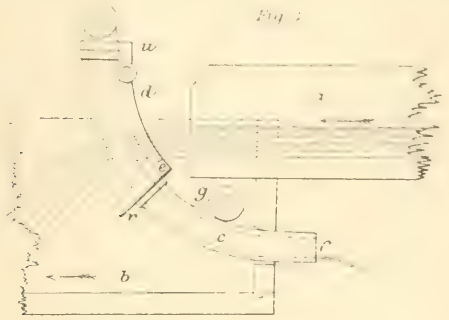


Fig. 2.

through the falling stream of pulp, some of which enters the slot, and is discharged from the end of pipe, *f*, into the sample receiver, *n*. The water runs out of the cistern, and the counterweight then brings the pipe back again



through the pulp to its normal position, and the whole cycle of operations is continuously and automatically repeated. It will be seen that the quantity of pulp collected in the sample receiver, *n*, in a given time depends upon the rate at which the cistern is allowed to fill, and may be regulated by altering the water supply by a cock on the pipe, *m*.

OBJECTIONS.

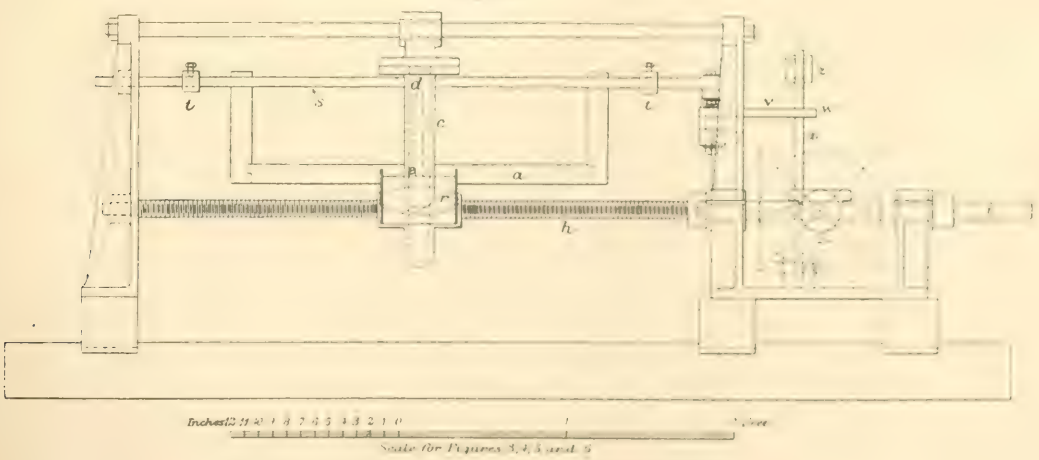
The lowest layer of pulp flowing in a launder is very likely to be of different value to that of the upper layers, and in the great majority of cases the lower part is richer in gold contents, and contains a more than average quantity of coarse sand and pyrites. Therefore, when, as in the apparatus described, the slotted pipe cuts through the pulp in a direction parallel to a vertical plane, unless the motion be absolutely uniform the sample will be imperfect, because the pipe will catch more of one layer than of another. Of course, the motion of the falling cistern or counterweight is not theoretically uniform, but this error is partly compensated, because it is in the opposite direction on the return stroke, and in any case it is probably not of great importance. Another objection urged against this type of sampler is that there is a pause in the motion of the pipe when it is passing through the stream, due to the resistance of the liquid. Such a pause, whether it occurs near the edge or at the centre of the stream is fatal to accurate sampling.

A little consideration will show that all these difficulties are obviated by taking a cut *horizontally* across the stream at a *uniform* speed, and at equal intervals of time with a *vertically* slotted pipe, the slot being long enough to take in the whole depth of the pulp. The shorter the interval is, the more perfectly will the sample represent the whole bulk of the material from which it is taken.

THE NEW SAMPLER.

Mr. J. Higham, the cyanide manager of the City and Suburban Company of Johannesburg, has realised these essential principles, and applied them in such a neat and effective manner that the writer has no hesitation in saying that the problem of automatic wet sampling has now been satisfactorily solved, both theoretically and practically, although, of course, there may

Fig 4.



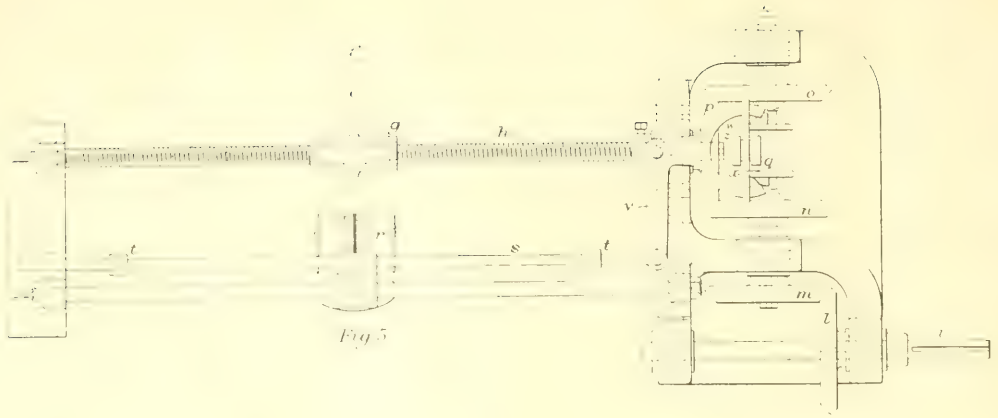


Fig. 5

still be room for further modification in the details. This machine is illustrated in figs. 3 to 7, for which the author is indebted to the courtesy of Mr. John Kelly, consulting engineer, of Johannesburg.

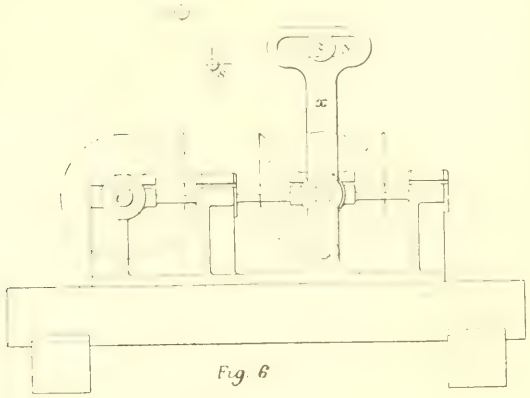


Fig. 6

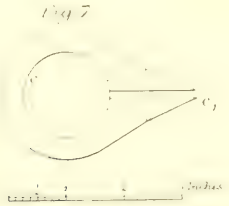


Fig. 7

DESCRIPTION OF DRAWINGS.

The pulp from the mill is delivered by the launder *a*, from the end of which it shoots over into the lower launder, *b*, as indicated in fig. 3. The principal, and, indeed, essential feature of the apparatus is the curved pipe, *c*, which is slotted vertically from *d* to *e*, and travels slowly to and fro across the full width of the falling stream, so that a small portion of the pulp is continuously entering the slot, and is discharged from the lower end, *f*, of the curved pipe. It follows, therefore, that the whole stream is being constantly and uniformly sampled. Fig. 7, which is drawn to a larger scale than the other figures, is a section through this slotted pipe, *c* ; it shows the shape of the slot, and also the removable piece, *c*, called the sample cutter, which is made of hard steel, and fits easily into the pipe. When worn at the edges by the action of the quartz particles, this cutter can be readily replaced by a spare one, and can be reground for use again, so that a slot with clean sharp edges is always presented towards the stream of pulp.

BULK OF SAMPLE.

The bulk of the collected sample, or, in other words, the relation between the quantity received by the pipe and the quantity which passes outside it, evidently depends upon the relative widths of the slot, and of the launder, *a*, and is independent of the speed at which the pipe moves. In the drawings the slot is $\frac{1}{8}$ in. wide, while the launder is 2 ft. in width, therefore the sampler will take one ton from each 192 tons delivered by the launder, or allowing for the slight extra travel of the pipe beyond the stream at the end of each stroke, say one ton from each 200 tons, or exactly half per cent. The extra travel is required, because the pipe must be outside the pulp during the inevitable pause which occurs while the motion is being reversed. If that pause occurred in the stream, a larger

quantity would be taken from the edges than from the centre, and the sampling thereby rendered imperfect.

In most cases such a large sample as half per cent. of the total output is not desirable, and there are various ways in which it may be reduced. For instance, this may be done by widening the launder, *a*, or by increasing the travel of the sample cutter considerably beyond the launder on each side, so that it is passing through the pulp for only a fraction of its total journey, in which case the sampling is intermittent instead of being practically continuous. There are evident practical limits to either of these modifications, and no very considerable reduction in the bulk of the sample can be conveniently effected thereby. The simplest and best way to obtain a very small sample is to adopt the method commonly used in sampling dry crushed ore, namely, to pass the collected product of the first sampler through a second one of the same kind. Suppose, for example, that for the pulp from a hundred stamp mill, say five hundred tons per day, two of the machines illustrated are used in succession, then the final sample from the second machine is only 28 lb., and this quantity will still represent with the greatest attainable accuracy the texture and value of the whole of the mill product. It may be remarked in passing that for many purposes, such as grading tests, the mechanical texture of the sample is just as important as its value.

MECHANICAL DETAILS.

Having now discussed the principles upon which the apparatus is designed, it only remains to consider the mechanical details in which the idea has been embodied. The pipe, *c*, carries a nut, *g*, which is threaded on the long rotating screw, *h*. The shaft, *i*, is driven in any suitable manner at a uniform speed, and its motion is transferred to shaft, *k*, by the mitre wheels, *lm*. Two other mitre wheels, *no*, running loosely on the shaft, *k*, are always in gear with a wheel, *p*, attached to the screw, *h*, which latter can therefore be rotated in either direction by throwing either *n* or *o* into gear with shaft, *k*, by means of the double faced clutch block, *q*, and this clutch is operated in the following manner: a horizontal striking rod, *s*, has two adjustable stops, *t t*, one of which is struck by a lug, *u*, projecting from the sampling pipe, *c*, when the latter reaches the end of its stroke, in either direction. The movement thus imparted to the rod, *s*, is transferred to the upright lever, *x*, by the forked end, *w*, of the bell crank lever, *v*. This upright lever operates the double clutch, *q*. It has at the top a slot, *y*, containing a roller, *z*, so that when the lever is slightly inclined in either direction, the roller naturally runs downwards along the slot, and by its impetus ensures the completion of the throw of the lever and the proper engagement of the clutch and mitre wheel. In this way the two mitre wheels, *n* and *o*, are alternately brought into gear with the shaft, *k*, and the reciprocating motion of the cutter is continually maintained.

A fence plate, *r*, is provided on the curved pipe, *c*, immediately below the slot, to prevent any of the pulp which strikes the outside of the pipe from dribbling down to the end, *f*, and so becoming mixed with the sample.

In the machine which has now been working for many months at the City and Suburban mill, the shaft, *i*, is driven by an electric motor, but in some cases it may be found practicable to drive it from a small water-wheel operated by the pulp itself, either before or after it has passed the sampler. In other cases the machine can be conveniently driven by suitable gearing from the battery shaft.

SOME UNDEVELOPED POSSIBILITIES IN THE ELECTRIC LIGHTING FIELD.

BY

J. WRIGHT.

A Paper on new forms of Arc and Incandescent Lamps considered in relation to their possible future development.—ED.

WE are most of us conversant by this time with the generally accepted principles of the arc and incandescent systems of electric lighting, and even, of late, with the Nernst Lamp, which is rapidly working its way into public favour. There are, however, several other types of lamp, involving the consumption of electrical energy to actuate them, of which we have heard from time to time, but only in a vague manner, conveying but little information as to their general construction and mode of operation.

THE COOPER-HEWITT MERCURY VAPOUR LAMP.

The Cooper-Hewitt Mercury Vapour Lamp, which created such a furore at the 1901 Conversazione of the American Institute of Electrical Engineers, where it was exhibited for the first time in an experimental stage, depends in principle on the incandescence of a column of mercury vapour by an electric current, communicated to the column by suitable electrodes.*

In 1892, L. Arons, of Berlin, described a discovery he had made in connection with some experiments in gaseous conduction. His apparatus consisted of an inverted U-tube, AB (fig. 1), with long and short limbs, A and B respectively. The extremity of B was closed, and provided with an electrode sealed into the glass, whilst that of A was open and communicated by a rubber tube, R, with the mercury reservoir, Hg, into which dipped a second electrode. The two electrodes were connected with a suitable current generator, D, through a regulating resistance (not shown in the fig.) To start the action the current was turned on, and the tube having been previously exhausted of air by means of a pump connected at P, was filled with mercury by raising the reservoir, Hg, so that the metal flowed over the bend into the shorter limb, B, and consequently into contact with the electrode embedded therein. The reservoir was then again lowered, and on the separation of the two columns of mercury at the bend, a brilliant electrical discharge, with a greenish hue, resulted.

ELECTRIC LIGHTING.

Following this discovery, the value of which was not appreciated by Arons at the time, came Mr. Peter Cooper-Hewitt's invention, which is very similar in principle, but does not require the primary establishment of a complete metallic circuit to start its action. The Cooper-Hewitt Vapour Lamp, in a form embodying the salient features of his most important discoveries in this field, is represented in diagram by fig. 2, where T is a vertical glass tube, of $\frac{3}{4}$ in. internal diameter, and some 54 in. in length. This tube is exhausted of air, and its lower end contracted and closed as shown; a small quantity of mercury, Hg, being introduced, which constitutes the negative electrode of the lamp, and is connected with the exterior by a platinum

* See also "The Cooper-Hewitt Mercury Vapour Lamp and Static Converter."—PAGE'S MAGAZINE, February, 1903.

wire sealed into the glass. Fitting closely inside the lower end of the tube, and surrounding the upper layers of mercury, is a porcelain cylinder, P, which acts as a species of conducting funnel for

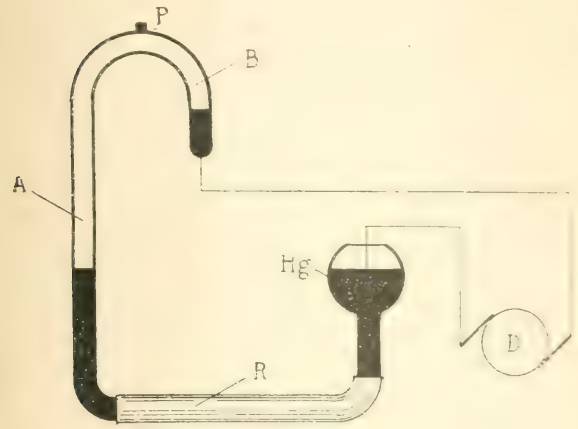


FIG. 1.

the vapour, and, by virtue of its small bore, concentrates it about one point on the surface of the mercury, thus preventing flickering of the light which would otherwise occur. F is a narrow band of tin foil, attached to the exterior of the tube at a point on a level with the surface of the mercury, and electrically connected with the positive terminal. Its function is to aid in starting the action of the lamp, by partially equalising the electrostatic condition of the tube at these two points; if the foil, F, be absent, the lamp is difficult to start, and, at best, requires the application of an initial voltage far above the normal working pressure. The upper extremity of the tube, T, is expanded into a bulb, A, as shown; this latter acts as a radiating chamber and dissipates any excessive heat resulting from the action of the lamp, which, if not eliminated, tends to increase the electrical resistance of the vapour column and ultimately to extinguish the lamp. The chamber, A, need not necessarily surround the upper positive electrode, B, but may be located anywhere on the tube, provided it be out of the direct path of the luminous column. The positive electrode, B, consists of a small cylinder of pure iron, supported by, and electrically connected to a platinum wire, which also is fused through the glass, and serves for exterior connection to the source of current. At an electromotive force of 120 volts, this lamp takes a current of some four ampères, at a normal surrounding temperature of 75 deg. F.

The efficiency of such lamps is extremely high compared with other incandescent lamps, varying from 0·3 to 0·6 watts per c.p. The main drawbacks to their adoption on a commercial scale are: (a) The inconvenient form of construction, even when modified and made up with curved and S-shaped bends. (b) The colour of the light—as it is remarkably deficient in the red rays, it has been proposed to remedy this by the introduction of such substances as iridium, sodium, thallium, etc., or even an atmosphere of nitrogen into the path of the vapour. (c) The working of the lamp is materially affected by changes in the temperature of the surrounding air, and it must in consequence be, as far as possible, protected therefrom.

Despite these, at first sight, serious defects, there would appear to be a future before the vapour lamp, if only on account of its greater efficiency, a very important consideration nowadays.

Later patents taken out by Mr. Cooper-Hewitt in the United States refer to a vapour lamp in which the foregoing defects are, for the greater part, overcome. The vapour chamber, instead of taking the form of an inconveniently lengthy cylinder as in the former lamp, consists instead of a pear-shaped globe, approximately equal in size to those of the average incandescent lamp. As represented in fig. 3, the positive electrode consists of a small plate, A, of any convenient metal, such as iron, provided with a platinum leading in wire, sealed into the glass of the pear-

FIG. 2.

shaped globe, G. The negative electrode, B, on the other hand, is a sphere or solid body, of any convenient shape, constituted entirely of such rare earths as are capable of being raised

to a high state of incandescence without becoming combustible. As in the Nernst lamp, it is not essential that the earth or earths comprising the negative electrode shall be conductors of electricity when cold, as there is a sufficient leakage path into the lamp to allow the necessary starting current to pass when the circuit is closed.

The negative electrode, B, is supported by a tube or cylinder of porcelain, P, or any similar material which retains its insulating properties throughout any possible temperature variations to which it is likely to be subjected in the action of the lamp. This is in turn sealed into the glass globe, electrical connection with B being secured by a platinum wire which passes through its centre. The globe contains an atmosphere of a suitable gas, rarified nitrogen, for instance, which, when the lamp is in action, becomes a conducting path of incandescent vapour, the emission of light being assisted by the incandescence of the negative electrode, B.

According to the claims put forward by the inventor, with the above atmosphere of rarified nitrogen, and with electrodes separated by a distance of some $1\frac{1}{2}$ in., the voltage required

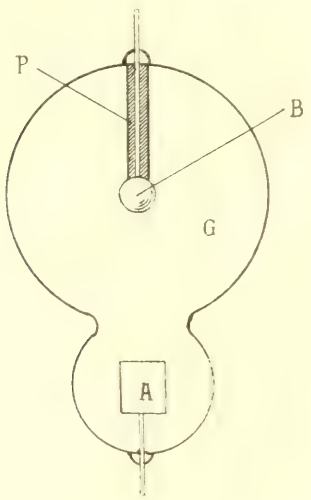


FIG. 3.

to start the action of the lamp is 750 or less, the current being uni-directional.

At first sight, the comparatively high voltage required to start the lamp would seem a serious obstacle in its path towards success as a commercial innovation, but the difficulty has been overcome in more ways than one, rendering the lamp applicable to any of the ordinary supply circuits, with the pressures at present obtaining. The starting device described and exhibited at the recent demonstration in London consisted of an ordinary inductance coil connected across the terminals of the lamp, the circuit of which when broken, gave rise to an "extra E.M.F.," or induced high voltage, which, though momentary, sufficed to overcome the initial resistance between the electrodes, and start the action of the lamp. Since that demonstration, another starting device, equally ingenious, has been described and illustrated in the American press. It is the invention of Dr. Weintraub, of the Research Laboratory of the American General Electric Company, and consists of a small branch tube, sealed into, and communicating with, the main stem of the lamp at a point approximately level with the surface of the mercury electrode. This branch tube also contains a supply of mercury, which normally forms part of a single mass contained by the main tube and itself, the bridging column being a horizontal layer of the metal which partially fills the connecting tube. A soft-iron float is immersed in the mercury of the branch tube, and its mass is so proportioned as to maintain a junction between the two columns by keeping the level of the mercury above that of the connecting yoke. This float forms the core of a solenoid wound round the branch tube, and connected in parallel with the lamp terminals; when the current is switched on, the solenoid becomes active, and raises the float, allowing the level of mercury in the branch tube to sink accordingly. As a result, electrical continuity between the two masses of mercury is destroyed, and an arc is set up between them, which, taking place in the electrical field created between the two main terminals of the lamp, suffices to start the action in the main stem. Once started, the lamp continues to work, and the starting solenoid is automatically cut out of circuit by an auxiliary electro-magnetic device.

The lamp is self-regulating, for the following reason: It is an acknowledged fact that the electrical resistance of a vapour varies inversely with the current; in the Cooper-Hewitt lamp, however, this phenomenon is compensated for by the increase of resistance to the passage of the current at the negative electrode. Provided, therefore, that there be no chemical or physical action at the latter, and that the various adjustments necessary to the working of the lamp be made, the latter becomes self-regulating through comparatively wide variations in the electromotive force of the current which feeds it.

A modified form of the same lamp comprises a spherical globe, the negative electrode being situated at its centre, and surrounded by the positive in the form of a ring.

Another objection to the mercury vapour lamp, viewed from a commercial standpoint, is its lack of portability, owing to the liability of fracture from the weight of mercury contained within the tube. It is, however, more than probable that this obstacle will be speedily surmounted, more than one patent having been already applied for in the States on a device designed with a view to eliminating the difficulty. So far, the general tendency leans towards a separate receptacle or pocket, hermetically sealed into the main lamp tube or bulb, and designed to receive and contain the mercury during transit, thereby relieving the lamp proper from the strain which would otherwise be imposed upon it.

THE OSMIUM LAMP.

The marked inefficiency of the ordinary incandescent lamp with a carbon filament, which may, and, in fact, frequently does consume as much as four or even five watts per candle power, has induced many inventors to turn their attention to the production of a filament which, whilst possessing the necessary strength and tenacity, and offering a sufficiently high electrical resistance to the passage of a current in proportion to its length, shall, at the same time, be to all practical intents and purposes incombustible, thus enabling higher temperatures to be attained without risk of fracture, and thereby increasing the efficiency of the lamp.

Following upon the successful experiments of Nernst, now so widely known, the rare earths seemed to offer a promising field for the selection of a substance which would fulfil the desired conditions.

The Osmium lamp, invented by Dr. Auer Von Welsbach, of incandescent gas mantle fame, closely resembles an ordinary incandescent electric lamp with carbon filament in general construction, the only real difference being in the material of which the filament is composed. Osmium, which was discovered by Tennant in 1803, is a metallic element, blueish white in colour, and practically infusible; it is harder than glass and is the heaviest known body. It is this substance which the inventor of the Welsbach mantle adopted as the material for his electric lamp filaments. The main difficulty in the way of its adaptation to the needs of an ordinary incandescent filament lay in its crystalline formation, which rendered it unfit to be worked in the ordinary way. Mr. W. Shapleigh, of the American Welsbach Company, appears, however, to have surmounted this obstacle, and produced a practical lamp, which, supplied with current at a potential difference of 25 volts, exhibited an efficiency of from ·9 to 1 watt per candle, as against the minimum 2½ watts per candle consumed by the ordinary incandescent lamp with its carbon filament. Furthermore, the decrease in efficiency with continued use is not so rapid as in the case of the carbon filament; an experimental osmium lamp with a starting efficiency of 1·45 watts per candle power was run for 1,500 hours, and at the end of the test its efficiency had only dropped to 1·7 watts, a creditable performance as compared with the ordinary incandescent lamp of commerce.

The osmium filament is of the hair-pin variety, and is used in a vertical position, owing to its extreme flexibility; this fact, coupled with the rarity of the metal, and the difficulty of obtaining a sufficiently high electrical resistance in a proportionately strong filament, owing to inequalities in the metal, appears to have at present militated against its introduction to the public on a commercial scale.

CRAWFORD-VOELKER LAMP.

The Crawford-Voelker, or carbide of titanium, lamp constitutes another attempt to oust the carbon filament from the incandescent field; it was invented by William Lawrence Voelker in 1897, since which time he has been experimenting with a view to perfecting the invention, and rendering it fit to compete with the universal carbon filament of to-day. The Crawford-Voelker lamp also resembles the ordinary incandescent bulb in general appearance, the main structural difference consisting in a bifurcation of the globe, extending down some distance from the cap or mounting of the filament. The dividing partition is of porcelain, and its object is to prevent an undue waste of electrical energy, which was shown by Sir William Preece to exist between the entering extremities of an ordinary incandescent lamp filament, owing to the passage of a current through the exhausted space between the two terminals. This lamp, like the high efficiency carbon variety, consumes at the start approximately 2·5 watts per candle power. Its general decadence in use is, however, far less rapid, as evidence the tests to which samples have been subjected by Col. H. C. L. Holden, F.R.S. With a starting efficiency of 2·533 watts per candle, these lamps, after 560 hours, only fell to 2·845 watts, and on a further extension to 1,000 hours of burning, the efficiency was 3·35 watts per candle power, this with a minimum life of 787 hours, which compares very favourably with the useful life of the carbon filament.

THE "PREMIER" LAMP.

The "Premier" or carbide of silicon incandescent lamp is the invention of Herr Langhans, and possesses a refractory filament, made by specially treating the cellulose prepared in the ordinary manner as adopted at present by lamp manufacturers, with silicon, in the form of a fine amorphous powder. The two substances are thoroughly incorporated by mechanical means, and the mass subsequently rotated to remove all air-bubbles. It is then squirted through dies in the ordinary way, and the thread thus produced is wound on frames, which are subsequently packed in a mixture of carbon powder and titanic acid. Protected in this manner from the action of the atmosphere, they are subjected for some time to a high temperature, which carbonises them. The subsequent "flashing" takes place in a vapour of carbon and silicon, and the filament is then ready for mounting in the bulbs. In other respects the construction of the lamp closely resembles that of the ordinary incandescent variety, but with the additional advantage of increased efficiency; a consumption of 3·1 watts per candle power being to all practical intents and purposes maintained throughout a life of from 600 to 800 hours. Another great advantage is the absence of the black deposit which invariably forms on the inside of globes carrying carbon filaments, and speedily detracts from the quality of the light emitted by them.

EDISON'S TUNGSTATE OF CALCIUM LAMP.

The general principle of electrical illumination by a high tension discharge in vacuum tubes is too well known to need enlargement here; Edison has, however, improved upon the plain vacuum as a result of his researches into the subject of X-rays. His tungstate of calcium lamp consists of an exhausted glass tube, into which has been previously introduced a quantity of crystals of calcium tungstate. These latter are subsequently fused by the application of X-rays to the tube, the latter being, meanwhile, slowly revolved so as to procure a thin layer of the substance over its interior surface. When subjected to the action of a high tension current produced by an induction coil or other suitable means, these tubes glow very brilliantly, but possess the attendant disadvantage that they cannot be worked for long at a time.

ARC LIGHTING.

Arc lighting, of course, offers a wide field for investigation, which has been mainly confined until lately to the method of automatic regulation of the carbons. The enclosed arc, whereby a partial vacuum is secured around the arc, and the consumption of the carbons thereby considerably lessened, is also a comparatively modern innovation, but, in view of recent progress in this direction, it can hardly be regarded as undeveloped. There is, however, a departure in arc lamp construction which promises increased efficiency, and that is in the Bremer patents, which refer, in the main, to the composition of the carbon rods themselves. These latter, instead of being carbon pure and simple, are impregnated with metallic salts containing such substances as fluorine. The proportion of these salts present in the electrodes may be as high as from 20 per cent. to 70 per cent., and it is claimed that by vapourising in the immediate neighbourhood of the arc itself, they greatly improve the quality of the light emitted.

A diagram relating to the Bremer arc lamp is represented in fig. 4, where C, C2, are the two

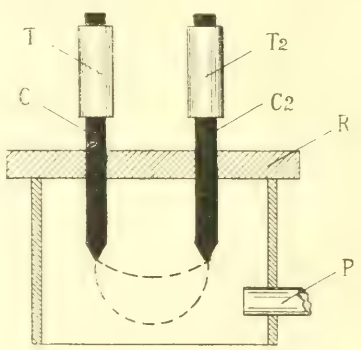


FIG. 4.

parallel composite rods, held in the conducting tubes, T, T2, which conduct the current to them. Their lower extremities pass through the roof, R, of a chamber, which surrounds the arc on all sides except at the bottom, whence the light is emitted. This chamber, which may be of any desired form, serves the double purpose of partially excluding the air, thereby keeping up the temperature of the arc, and at the same time acting as a base upon which is deposited a white product of combustion, completely lining the chamber and forming an admirable reflecting surface. The arc is of the shape shown by the dotted lines, and its surface is further increased by the repellent action exerted by the pole piece, P, of an electro-magnet, the winding of which is connected in series with the arc.

IMPERIAL TRADE AND TARIFFS.

By BENJAMIN TAYLOR, F.R.G.S.

Although PAGE'S MAGAZINE is in no sense of the word a political journal, we think no apology is needed for the publication of an article, based upon the recent proposals of Mr. Chamberlain, since they affect the whole of the industries with which the Magazine is concerned. At the same time we have no wish to enter into any species of partisanship, and we must again draw attention to the fact that we do not necessarily share the opinions of contributors.—ED.

THE whole business community has been stirred by Mr. Chamberlain's projection of inter-Imperial trade relations into the arena of practical politics. Men are now brought practically face to face with a question which has been hitherto only provisionally contemplated. For twenty years or so we have all talked about and mused about Imperial Federation, but we have not got any nearer to it—not even, as was fondly hoped, by the foundation of the Commonwealth of Australia. But that Imperial union may exist without political federation the Colonies have shown us in South Africa; and that reciprocal trade arrangements may be made without one common tariff, Canada has shown us by her differential scale.

BEGINNING A NEW CHAPTER.

It was with reference to the self-governing Colonies and their population of ten millions of our own race, Mr. Chamberlain spoke at Birmingham in dealing with reciprocity as a means towards Federal Union:—

"I hear it stated (he said) that our trade with those Colonies is much less than our trade with foreign countries, and therefore it appears to be their opinion that we should do everything in our power to cultivate that trade with foreigners, and that we can safely disregard the trade with our children. Now, sir, that is not my conclusion. My conclusion is exactly the opposite. I say it is the business of British statesmen to do everything they can, even at some present sacrifice, to keep the trade of the Colonies with Great Britain, to increase that trade, to promote it even if in doing so we lessen somewhat the trade with our foreign competitors. And why? Because if we do not make for Union we shall drift to separation. Supposing, when self-government was first conceded to these Colonies, the statesmen who gave it had had any idea of the possibilities of the future, do you not see that they might have laid broad and firm the foundations of an Imperial edifice to which every party would have contributed something to the strength of the whole? But in these days the one idea of statesmen was to get rid of the whole business. They believed that separation must come; what they wanted to do was to make it smooth and easy, and none of these ideas, which subsequent experience has put into our minds, appear ever to have been suggested to them. By their mistakes and by their neglect our task has been made more difficult—more difficult, but not impossible. There is still time to consolidate the Empire. We also have our chance, and it depends upon what we do now, whether this great idea is to find fruition, or whether we will for ever dismiss it from our consideration and accept our fate as one of the dying Empires of the world. Now, what is the meaning of an Empire? What does it mean to us? We have had a little experience. We have had a war, a war in which the majority of our children abroad had no apparent direct interest. We had no hold over them, no agreement with them of any kind, and yet at one time during this war, by the voluntary decision of these people, at least 50,000 colonial soldiers were standing shoulder to shoulder with British troops, displaying a gallantry equal to their own and the keenest intelligence."

It is true that the Colonies are not as generous as they might be in financial support to the defences of the Empire. But they will improve, and this is how Mr. Chamberlain lays down the position:—

"My idea of British policy, I mean the policy of the United Kingdom in that case at the beginning of things at the beginning of the new century, we ought to show our appreciation, our cordial appreciation, of the first step to be taken by our Colonies to show their solidarity with us. Every advance which they make should be reciprocated. We should set ourselves a great example of community of interest, and above all, that community of sacrifice on which alone the Empire can permanently rest. I have admitted that the Colonies have hitherto been backward in their

contributions towards Imperial defence. They are following their own lines. I hope they will do better, but in the meantime they are doing a great deal, and they are trying to promote this union, which I regard with so much importance, in their own way and by their own means. And first among those means is the offer of preferential tariffs. Now, that is a matter which at the present moment is of the greatest possible importance to everyone of you. It depends upon how we treat this policy of the Colonies—not a policy inaugurated by us, it is a policy which comes to us from our children abroad—it depends upon how we treat it whether it is developed in the future, or whether it is withdrawn as being not acceptable to those whom it is sought to benefit. The other day, immediately after I left South Africa, a great conference was held for the first time of all the Colonies in South Africa—the new Colonies as well as the old. Boers and the Dutch were represented as well as the British—and this conference recommended the other Legislatures of the different Colonies to give to us, the Mother Country, preference upon all dutiable goods of 25 per cent. Last year, at the conference of Premiers, the representatives of Australia and New Zealand accepted the same principle. They said in their different Colonies there might be some difference of treatment, but so far as the principle was concerned they pledged themselves to recommend to their constituents a substantial preference in favour of goods produced in the Mother Country. Now, that again is a new chapter in our Imperial history, and again I ask, Is it to end there ? In my opinion these recommendations and these pledges will bear fruit just in proportion as you show your appreciation of them, and they will depend largely upon the experience of Canada, which has been their precursor in a similar movement."

ATTITUDE OF THE COLONIES.

At the Conference of Colonial Premiers in London in 1902 the subject of commercial relations was freely discussed. Mr. Chamberlain explained that a system of Free Trade within the Empire, if it could be attained, would lead to the rapid and profitable exploitation of its boundless natural resources, and at the same time promote the natural and healthy growth and expansion of its manufacturing industries. It would change the various parts from a series of commercial units to an organic whole, the strength and solidarity of which would grow in proportion with its commercial and industrial development, and would lead inevitably to that closer political union which is so generally desired. At the previous Conference, in 1897, the Prime Ministers passed two resolutions on this subject, the first urging the early denunciation of any treaties which hampered the commercial relations between Great Britain and the Colonies, and the second undertaking to confer with their colleagues with the view of seeing whether an improvement of the trade relations between the Mother Country and the Colonies could properly be secured by a preference given by the Colonies to the products of the United Kingdom. Following on these resolutions, His Majesty's Government denounced the treaties with Germany and Belgium, and the Dominion of Canada, which had given a tariff preference of 12½ per cent.—increased to 25 per cent. in 1898—to the products of the United Kingdom, offering a similar reduction to the products of any country where the Customs tariff on Canadian produce was as favourable as the Canadian tariff, so reduced, was to the products of such country, on the termination of the treaties which confined this preference to the products and manufactures of the United Kingdom and certain British Colonies. This preference was, in 1900, increased to 33⅓ per cent. of the duty, and its results so far on the trade between the United Kingdom and Canada were fully discussed. A motion was submitted on behalf of the Government of New Zealand to the following effect :—

" That it is essential to the well-being of the Mother Country and His Majesty's dominions beyond the seas, that in such dominions where the same do not now exist, preferential tariffs by way of rebate of duties on British-manufactured goods carried in British-owned ships should be granted, and that in the Mother Country rebate of duty on Colonial products now taxable should be conceded."

The discussion, it was reported, revealed a very strong feeling amongst the Prime Ministers in favour of making some definite advance towards establishing closer trade relations between the Mother Country and the Colonies, and then it was resolved that the several Prime Ministers should meet the President of the Board of Trade privately, with the view of considering such separate arrangements as would best meet the varying circumstances of the several Colonies. The result of the informal meetings with the President of the Board of Trade was set forth in the following memorandum :—

" As a result of the communications which have taken place, it is understood that the representatives of the Colonies hereinafter mentioned are prepared to recommend to their respective Parliaments preferential treatment of British goods on the following lines :—

Canada.—The existing preference of 33⅓ per cent. and an additional preference on lists of selected articles—

(*a*) By further reducing the duties in favour of the United Kingdom.

(*b*) By raising the duties against foreign imports.

(*c*) By imposing duties on certain foreign imports now on the free list.

Australia.—Preferential treatment not yet defined as to nature or extent.

New Zealand.—A general preference by 10 per cent. all-round reduction of the present duty on British manufactured goods, or an equivalent in respect of lists of selected articles on the lines proposed by Canada, namely :—

(*a*) By further reducing the duties in favour of the United Kingdom.

(*b*) By raising the duties against foreign imports.

(*c*) By imposing duties on certain foreign imports now on the free list.

The Cape and Natal.—A preference of 25 per cent.

or its equivalent on dutiable goods other than specially rated articles to be given by increasing the duties on foreign imports."

The general resolution finally adopted by the Conference as covering the principle underlying the several proposals was as follows :—

"1. That this Conference recognises that the principle of preferential trade between the United Kingdom and His Majesty's dominions beyond the seas would stimulate and facilitate mutual commercial intercourse, and would, by promoting the development of the resources and industries of the several parts, strengthen the Empire.

2. That this Conference recognises that, in the present circumstances of the Colonies, it is not practicable to adopt a general system of Free Trade as between the Mother Country and the British dominions beyond the seas.

3. That with a view, however, to promoting the increase of trade within the Empire, it is desirable that those Colonies which have not already adopted such a policy should, as far as their circumstances permit, give substantial preferential treatment to the products and manufactures of the United Kingdom.

4. That the Prime Ministers of the Colonies respectfully urge on His Majesty's Government the expediency of granting in the United Kingdom preferential treatment to the products and manufactures of the Colonies, either by exemption from or reduction of duties now or hereafter imposed.

5. That the Prime Ministers present at the Conference undertake to submit to their respective Governments, at the earliest opportunity, the principle of the resolution, and to request them to take such measures as may be necessary to give effect to it."

THE ISSUE—AN IMPERIAL RECIPROCITY EXPRESSED IN PREFERENTIAL TARIFFS.

The issue raised by Mr. Chamberlain is, "whether the people of this country really have it in their hearts to do all that is necessary, even if it occasionally goes against their own prejudices, to consolidate an Empire which can only be maintained by relations of interest as well as by relations of sentiment." The issue as thus raised involves consideration not of an Imperial Zollverein, but of Imperial reciprocity expressed in preferential tariffs. There is a wide difference between the two. Either may make for political union, but while one has never seen a Zollverein without political union, there have been frequent instances of commercial union between separate political entities. Cases in point are the former Reciprocity Treaty between Canada and the United States, the Customs Union in South Africa, and the alliance pending between the United States and Cuba. On the other hand, there have been political unions without Customs Unions, as, for instance, between England and Scotland in the seventeenth century, between Great Britain and Ireland in the early part of the nineteenth century, and between the provinces of France before the Customs barriers were removed. A Zollverein or Customs Union, however, has never existed without political unity. It is found in the German Empire and in the American Republic—each a federation of States with separate Governments, and even separate social laws, but with one commercial law, one tariff, one system of money. And a Zollverein implies absolute Free Trade between the States associated, with or without (but in practice with) a single Customs barrier against the rest of the world.

Now, the outlying members of the British Empire are not as yet prepared to adopt the same Customs duties as the Mother Country, because they depend for revenue mainly on indirect taxation, and indirect taxation in these new countries falls mainly on imports. Some of the Colonies are deliberately Protectionist in policy, and regulate their tariffs accordingly, but even when Colonial tariffs are levied for revenue solely, they must fall upon a wide range of commodities which in the Mother Country, and in other Colonies, are free Take India, for instance, which raises so much of its revenue from a duty on salt, an article which is duty free in almost all other parts of the Empire. An Imperial Zollverein is impossible until either the Mother Country abandons Free Trade or all the Colonies and Dependencies adopt it. Neither position is yet within the range of practical politics, but what is meantime proposed is a system of preferential arrangements in the matter of tariffs within the Empire. It is not to be denied that this will be an extremely difficult thing to manage, but it is not impossible—if the several communities concerned are convinced of the necessity and desirability of it.

One great economic reason in favour of Imperial reciprocity is that it must almost certainly end—though the development may take some years—in a Zollverein, which would mean pure Free Trade within the Empire. But Free Trade within the Empire could not be maintained without a Customs for revenue for such of the Imperial States as have not sufficient forms of direct taxation. The question arises, Why should there not be an Imperial Customs for subdivision among all the members of the Empire, just as the Dominion Tariff suffices for all the provinces of Canada, and the Commonwealth Tariff for all the States of Australia? That, however, is a condition which must follow, not precede, political unity, and political unity will be promoted by preferential tariffs, which will create and sustain a direct and intense community of interests.

THE FREE TRADE DOCTRINE.

To those who have [illegible] and [illegible] to see [illegible] sphere of Free Trade it is no doubt disquieting to have an issue presented which seems to involve a reversal of the national fiscal policy. But Free Trade is not a [illegible], it is only a doctrine. And it is quite a mistake to ascribe all our economic growth and commercial prosperity to its influence. People do not consider how [illegible] the commercial prosperity and the spirit of adventure which in modern times has taken the form of colonisation are interrelated in the history of our

national development. The British Isles contain a population of forty millions. The British Empire contains a population of 400 millions. It is in the making of that Empire, more than in the practice of Free Trade, that Great Britain has developed her trade and extended her foreign connections.

The point to be made clear to doubters is that Reciprocity between the several self-governing States of an Empire is in perfect accordance with the principles of Free Trade.

THE TRAMMELS OF THE POLITICAL SCHOOLS.

Reciprocity is the commercial or commercial treaties, and commercial treaties were encouraged and promoted in this country by Richard Cobden, the great Apostle of Free Trade. The purpose and effect of all preferential tariffs is to enfranchise the trade between the countries adopting them. It is not to be denied that while some of the Colonies are Protectionist, all of them have shared in the benefits which Free Trade has conferred on the Mother Country. There is no economic reason why they should not reciprocate by returning to the Mother Country some of the benefits they enjoy, or fancy they enjoy, through their high duties on imports. Even Richard Cobden could not object to us accepting such benefits as Canada, for instance, conceded, even if they do annoy Germany. He would probably have been one of the first to extract an object-lesson in Free Trade, for the education of Germany, out of the incident. But in any case we must decline to be fettered for ever in our fiscal policy by considerations of what Richard Cobden would have thought fifty years ago. Times and circumstances have changed since the Manchester School served its day and generation. In none of the teachings of the old economic schools do we find precedents for dealing with the conditions as they now exist. Great Britain has not, as was hoped and predicted, converted the world to Free Trade, but she has encircled the world with her Empire. If that is to be an Empire "one and indivisible," those upon whom its glories and its responsibilities devolve must be prepared to sacrifice something more than the trammels of the schools.

STRENGTHENING THE EMPIRE BY COMMERCIAL BONDS.

To the conservative islander there is always something of such suspicion as attaches to the idea of sentiment in the policy of Imperialism, but neither individuals nor communities are the worse for an infusion of sentiment. It is, indeed, the essence of patriotism. The Colonies, the Dependencies, are children of the Mother Land. If, when they are strong enough, they desire to walk their own road, we do not object. But if, when they are strong enough to walk their own road they elect to march with us, we must not allow the doctrinaires to forbid us to accept their company. If any one of them were to get into social or economic trouble now we should find it our pleasure as well as our duty to afford it national help. If any one of them were attacked we should call forth, if necessary, the whole resources of the Empire to defend it. The idea of Imperialism may be infused with sentiment, but the real ties of Empire are strong as steel. They may be made stronger by the tightening of commercial bonds. It is, no doubt, true that the volume of our commerce with all foreign nations is larger than the volume of our commerce direct with the Colonies. But such a comparison does not cover the whole circuit of inter-Imperial relations. There is a vast and ever-growing intercourse between the several members of the Empire. It is our duty and privilege to promote that intercourse. It is, moreover, the part of wisdom to provide against the time when the volume of trade within the Empire may at least equal, and perhaps excel, that without the Empire. Who, for instance, shall limit the commercial possibilities of the Dominion, or the Commonwealth, or federated South Africa? It is possible that we may lose something to begin with in making preferential tariff arrangements with the Colonies as they now are, but we shall gain by the expansion of trade within the Empire.

HOW IT WORKS IN AMERICA.

Observe the effect of intra-American free trade. It is easier to send steel from Nova Scotia to Maine than from Ohio, or cheaper to send pig iron to Texas from Glasgow by sea than from Alabama or Illinois by land. But goods passing between these States are free of duty, and all passing in from Canada or Great Britain have to pay heavy tribute. Maine is geographically part of Canada, but, being politically part of the United States, has to pay duty on everything brought a few miles across the Canadian border, though it can import free of duty all it can import from far-off Oregon, on the other side of the Continent. There are probably no trade interchanges at all between Maine and Oregon or California. At all events, the material and personal interest of each State in the other is of the slenderest. They are more widely separated by land than Canada is from Britain by sea. They are practically as far apart, for trade purposes, as Canada is from Cape Colony, and as Cape Colony is from Australia. It is a longer sea voyage from New York to San Francisco than from London to Melbourne. It is a longer sea voyage from Portland, Maine, to Portland, Oregon, than from Newcastle-on-Tyne to Newcastle, New South Wales. There is a more friendly and sympathetic tie between Montreal and Melbourne than there is between Connecticut and Carolina. There is nothing, therefore, in geographical situation, or in national affection, or in political surroundings, to prevent in the British Empire such an inter-State free exchange of trade as exists on the American Continent, and now extends, indeed, beyond it, to Puerto Rico and Hawaii. But the Colonies are not prepared to admit free of duty all the goods of all the other Colonies and of Great Britain, because some of them cannot raise enough revenue without a large Customs tariff. Queensland and New South Wales want to keep out European beet sugar, and to encourage the cultivation and refining

of sugar within their own borders. But if they put on heavy import duties they will now exclude the sugar of the British Empire, that is of the East and West Indies. It is a far cry from Sydney, Cape Breton, to Sydney, New South Wales, yet at both places the manufacture of iron and steel has commenced, or is in preparation.

IMPERIAL UNITY AND COMMERCIAL UNITY INSEPARABLE.

What the people of this country have got to consider is the proposition that Imperial Unity and Commercial Unity are inseparable. If Great Britain as a nation is determined to carry out to its grand issues the idea of a comprehensive and cohesive British Empire, she must make up her mind on this question of trade and commerce. The keynote of Mr. Chamberlain's Birmingham address is that Imperial unity involves commercial solidarity. But Imperialists cannot regard this question of preferential trade within the Empire from a purely economic point of view. Free Traders must not believe that Free Trade was part of the Sermon on the Mount, worship it as a fetish, or accept it as anything but a means to an end. Free Trade is to be adapted to the National needs and advantages. The idea of reciprocal or preferential trade is only repudiated with horror by those who regard it as a form of Protection which Richard Cobden and John Bright would have denounced. But we are not concerned with what Richard Cobden and John Bright would have thought and said in their day and generation. It is not necessary for economic health to live for ever in the atmosphere of the Manchester School. The question from the Imperial point of view is not merely the effect on the fiscal system of the Mother Country, but, as Lord Rosebery puts it, whether the system of reciprocal tariffs will really bind the Mother Country more closely with her Colonies than is now the case. If we feel that it will, then the change can be made with alacrity. And we need not fear foreign reprisals, because the British Empire will then be the largest consumer in the world, too good a customer for any country to quarrel with, and we need not trouble ourselves with the adverse comments of foreign speakers and writers. All we need is to have the Colonies with us.

OUR TRADE WITH THE COLONIES.

According to the usual annual Blue Book the returns for 1902 show that the total of our foreign trade, including both exports and imports, amounted for that year to £877,630,000, being an increase of £7,700,000 as compared with the previous year, and of £13,000,000 as against 1898, since which date, with the exception of one year, the advance has been constant. The trade of the Mother Country with her Colonial possessions and protectorates last year amounted to £224,300,000, being roughly 26 per cent of the whole, the remainder being with foreign countries. The actual amount and percentage of increase for both classes of trade during the five years 1898-1902 were:—

Total of Imports and Exports	1898 £	1902 £	Increase Amount £	Increase p.c
From and to foreign countries	574,825,000	653,320,000	78,495,000	13.6
From and to British possessions	189,734,000	224,305,000	34,571,000	18.1
Total	764,559,000	877,625,000	113,066,000	14.7

The gain of the Colonies as regards the percentage of the gross total seems small, but the positive growth of the trade as against that with foreign countries is greater by more than 5 per cent. This movement in favour of the Colonies has progressed steadily since 1897, notwithstanding the South African War, whereas the trade with foreign countries has been subjected to considerable fluctuations, the highest total of £665,894,000 being reached in 1900. The comparative steadiness of the development of Colonial commerce in the period indicates durable principle of growth. If the foreign trade be divided into imports and exports, facts emerge which explain the desire of the Colonies for an Imperial Zollverein. The following comparison gives a general view of the respective movements:—

Imports	1898 £	1902 £	Increase Amount. £	Increase p.c
From foreign countries...	370,922,000	421,598,000	50,676,000	13.5
From British possessions	99,623,000	109,703,000	10,080,000	9.2
Total	470,545,000	531,301,000	60,756,000	12.1

Exports	1898 £	1902 £	Increase Amount £	Increase p.c
To foreign countries	203,903,000	231,722,000	27,819,000	13.6
To British possessions	90,111,000	117,933,000	27,822,000	30.8
Total	294,014,000	349,655,000	55,641,000	18.9

Our imports from foreign countries have increased in a considerably greater ratio, both relatively and positively, than those from our Colonies and possessions, but the exact reverse is the case with our exports. Taking the total value of the entire trade we benefit relatively less from the Colonial than from foreign trade at the same time we largely increase our sales to them. So far, the Colonies have some reason for complaint, seeing that our imports from them have not advanced in a corresponding ratio to our exports to, but our purchases from the Colonies consist mainly of foodstuffs and raw materials, whereas of the total increase in our purchases from foreign countries over £50,000,000 was in respect of manufactured goods. That class of imports last year amounted to nearly a hundred millions. A preliminary remedy

imports would easily compensate for any loss of revenue in differentiating on Colonial products.

DISTRIBUTING THE NATIONAL RISKS.

There are many considerations affecting the sources of our food supply. It is, for instance, desirable to increase the number of these sources so as to distribute our national risks more. The earnest desire of the cotton-spinners in this country just now is to find some other field for the production of medium cotton than the United States. Such a field it is hoped and expected to find in our West African Colonies, and if these expectations are realised the Imperial advantages will be enormous. Then as to corn and flesh meat, we are now relying to a considerable extent on our Australasian possessions. But these are far away, and in any case the supply is yet insufficient, though New Zealand is preparing to be her own salesman at our doors. For relief from dependence on foreign purveyors we must look mainly to Canada. From the St. Lawrence, or Hudson Bay, to the West Coast of Scotland is a seaway that can be covered by swift steamers in four to five days. This is an ocean highway with the smallest amount of risk of any open to us. It is a line of traffic short and direct, which could be constantly patrolled in war time by swift and powerful cruisers as scouts and convoy. Along this line of seaway from Dominion to Mother Land the wireless telegraph could regulate the traffic from some Hebridean mountain, directing the food ships to such ports north or south as may present the clearest approach at the moment. There are dozens of Highland lochs into which a grain carrier could fly for safety from an enemy's cruiser, into which the cruiser could not follow. A few miles of light railways would bring our markets into direct communication with these outposts, from which we could draw our food supplies while the enemy was haunting the sea lanes to Clyde or Mersey or Channel. With the opening up of the prairies and cattle ranches of Canada, the trans-Dominion railway, the all-British cable, a securely guarded Anglo-Canadian ocean roadway, and a preferential tariff, we should have an all-British supply of food, which it would require all the navies in the world to deprive us of.

DIFFICULTIES.

For the successful prosecution of her industries the Mother Country needs not only an ample but a cheap supply of the necessaries of life, and of the raw material for her manufactures. The Colonies cannot—as yet, at any rate—supply all we want of either, and an Imperial Zollverein would imply that we should have to tax something of what we import from foreign countries. This is where the difficulty comes in. Take, for instance, cotton. This is the raw material of several of our leading industries, and we derived last year 337,000 cwts. of it from British India, as compared with 16,000,000 cwts. from America and other foreign countries. If we are in future to tax the 16,000,000 cwts. in order to let the 337,000 cwts. in free, we shall *pro tanto* raise the cost of the finished products, in the sale of which we have to compete with America, Germany, and Japan. In the case of wool, another raw material for a staple industry, the position is different, because about five-sixths of what we import comes from Australasia and other British possessions. But we also get a large and increasing quantity from Argentina, and Argentina is a large and increasing market for our manufactures. The British Empire produces more than it consumes of most things, and therefore needs foreign outlets for its surplus. But it does not produce as much as it consumes of some things, and these things are so essential to its commercial prosperity that we cannot have them barred by taxation. And Mr. Chamberlain, for one, is opposed to the idea of taxing the raw material of our national industries. We shall have, in due time, to weigh the comparative advantages and disadvantages of taxes upon manufactures such as we produce at home, and taxes upon foodstuffs such as we produce in the Colonies. And here it may be suggested that as the rise and fall of freights does not appreciably restrain or increase the shipment of American food products to this country, it is not probable that a moderate duty on American iron, steel, and machinery would materially affect the shipments of these commodities.

CONCLUSION.

The problem to be solved is, how to promote intra-Imperial trade without injuring extra-Imperial trade. In approaching the question, we in the Mother Country have this to consider—that the axis of the world's industries is changing. Within the not very distant future we shall probably see Canada the centre of the iron and steel industries, and Canada, Australia, and India the purveyors of coal in the whole Pacific basin. From an Imperial point of view it may not matter whether Britain transfers her iron trade from Scotland to Nova Scotia, or stocks her coaling stations from New South Wales or from old South Wales. The Empire has immeasurable and inexhaustible means of wealth, but in the process of redistribution some parts of it must suffer. We must aim at preserving the whole.

LOCOMOTIVE ENGINEERING NOTES.

Some Great Western Novelties.

It is already evident that Mr. Churchward's accession to the Swindon chieftaincy is to be the starting point of several important new departures on the Great Western Railway. Whether the startling locomotive novelty, No. 100, which came out during his predecessor's last year of office, should more justly be accredited to that predecessor or to Mr. Churchward himself, it does not rest with the present writer to determine; that in its pointed divergence from pre-existing Swindon methods it might not unreasonably be conjectured to be the product of the newer mind is no doubt true. At the same time it must be remembered that it did not possess more aggressive characteristics of novelty than did the very fine coupled express engines of the "Atbara" class or than those remarkable goods engines which have six-coupled wheels with inside cylinders, outside bearings, and leading two-wheel or four-wheel bogies. All of these seem to bear the impress of a "new broom." But it is profitless to indulge in speculation. According to accepted custom, locomotives that have come out during the reign of any particular chief mechanical engineer must be regarded as presumably of his design. Therefore, however novel—in some respects even startlingly so—may be the "Camel," "Atbara," "11," "36," "100" and "2600" types, they must conventionally be deemed to belong to the dynasty recently expired.

But however this may be, no such doubt or question can arise as regards certain new engines that have just been built, or are in course of construction, or are on the drawing-sheets at Swindon; and these are both numerous and important. During a recent visit to the Swindon works, the writer of these notes was most courteously afforded by Mr. Churchward much valuable information and the opportunity of seeing a great deal that possessed the highest interest from a locomotive engineering viewpoint. In the first place a new batch of 6-ft. 8-in. four-coupled express bogie engines may claim notice. These virtually carry on the "Atbara" succession, but differ from their progenitors in respect of several considerable details. Chief among these is the new design of boiler used. British engineers have [illegible] awaking during the past few years to the recognition of the fact that had previously impressed itself very powerfully upon the minds of their brethren of the European and American Continents, namely, that the supreme and all-important feature in the locomotive engine is its boiler, and that no other point or points of excellence will compensate for any deficiency in the relative capacity of this vital part of a locomotive's economy. It has come to be realised that 900 to 1,000 square feet of heating surface, such as the famous brothers Stirling gave to their finest and most powerful engines designed for the fastest and heaviest express work, is wholly insufficient. But—and this is equally important—it has also come into recognition that mere area of heating surface is only one factor in the problem of boiler efficiency, and that very large heating surface area may co-exist with very small boiler efficiency. Locomotives were constructed so long ago as the "forties" with larger heating surface than that possessed by all save a numerically insignificant few of present-day engines. Yet no one dreams of imagining that the steam generative capacity of their boilers was even remotely correlative to their proportionate area of heating surface. Nowadays, it is growing to be understood that the question "how much" in regard to heating surface is of greatly inferior [illegible] "where."

Boiler Novelties.

[illegible] declared to the writer that he can obtain value through- [illegible]

has been for some time in experimental use on the London and South-Western. But however doctors may differ on all other points of boiler design and construction, there does not appear to be the slightest divergence from unanimity as to the supreme desirableness of getting as much heating surface as possible around and close to the firebox itself. This constitutes the salient principle of Mr. Churchward's latest departure as regards boiler construction, and, as was mentioned in my last month's notes, he has adopted the boiler form which in America is known as the" extended wagon top," but which in this country there is a disposition to describe as the "taper" form. The latter has the great advantage of brevity as compared with the somewhat lumbering American designation, which really conveys in itself little of direct or accurate meaning. The misfortune about the briefer English term is that it is somewhat misleading, and has a tendency to convey an idea rather the reverse of that which is meant. To "taper" is commonly understood as implying the gradual diminution of diameter. It may be said that the "taper" boiler does taper off from the firebox toward the smoke-box. That is quite true, but, unluckily, it inverts the true inwardness of the meaning because the merit of the "taper" or "extended wagon top" boiler is not that it diminishes in size toward the smoke-box, but that it *expands in size toward the firebox*—that instead of maintaining its comparatively small smoke-box diameter up to the point where it joins the firebox, while the latter towers hugely above it, as in the case of the Great Western "Camels" and earlier "Atbaras," the boiler form now used by Mr. Churchward steadily expands along its whole course until, by the time it reaches the large Belpaire firebox, it is practically equal to that in diameter.

Practical Advantages.

It will at once be realised that this form of construction, while by no means æsthetically pleasing, at any rate until the eye shall have become used to the novelty, does undoubtedly afford a large increment of heating surface in the precise locality where that is most needed and where it is most efficient in steam generation; that is to say, directly adjacent to the firebox. The new four-coupled express engines already referred to are fitted with boilers of this type. So is No. 98, the second of the large ten-wheeled 6-ft. 8-in. six-coupled express engines of which No. 100 was the pioneer, and one immediate result is that the engines thus acquire not only a considerable addition of actual heating surface, but also so superior a *quality* of additional heating surface that it really represents in efficiency a good deal more than the mere nominal increment, and it may reasonably be expected that the fine steaming qualities which have made the "Camels" and "Atbaras" such marked successes will be found even enhanced in these "taper" boilered successors. But the new boiler form is in course of application to several other Great Western locomotive types now in course of design or construction, and these in themselves constitute departures of sufficiently marked novelty to merit some special detailed references.

Some New Locomotive Types.

One of the most remarkable of these is intended for heavy goods and mineral traffic between South Wales and the Metropolis *viâ* the Severn Tunnel. Like all the newest types of British goods engines, it has eight-coupled wheels. Britain's tardy adoption of a method which has so long been in extensive use in every other part of the world finds its latest convert in the new Swindon chief. But Mr. Churchward's colossus, unlike the colossi of Messrs. Webb, M'Intosh, Ivatt, Worsdell, and Robinson, possesses what those others lack—a leading two-wheel bogie or pony-truck. It is, in fact, an engine type known in America and the Colonies as the "Consolidation." It has a vast boiler of extended wagon top order, and it conforms to the modern British method which is virtually the adoption of the long-existent European and American method of having coupled wheels only 4 ft. 3 in. to 4 ft. 7 in. in diameter for goods traffic. It may be remarked here what curious conservatism has been displayed by British designers in adhering for more than half a century to the stereotyped wheel-diameter of 5 ft. for slow and heavy goods traffic, thus losing an appreciable proportion of the tractive force which might have been available without gaining any substantial benefit, the argument in favour of larger wheel diameter which may be applicable in the case of express engines entirely failing to apply to those intended purely for slow service. Noticing the curious habit which has been so prevalent of late of employing six-coupled goods engines with 5-ft. wheels on express duty, one is disposed to wonder whether this can possibly have been foreseen when the diameter of 5 ft., relatively large for heavy goods and mineral service, was so persistently adhered to instead of the smaller diameter of 4 ft. 3 in. to 4 ft. 7 in. used in the eight-coupled engines now being generally employed. Mr. F. W. Webb, the late Chief Mechanical Engineer of the London and North-Western, appears to have been the only Britsh locomotive superintendent who systematically employed in his six-coupled mineral engines, wheels of smaller diameter than 5 ft.; those of Mr. Webb's "coal engines" were 4 ft. 3 in. The newer British method, which is, of course, the older European and American plan, certainly seems to have much to recommend it from a practical standpoint.

Two Novel Tank-Engine Types.

Two other departures from the normal which are in course of preparation at Swindon belong to the tank-engine class. One of these, which is already in course of construction, is a ten-wheel tank-engine which has six-coupled 5-ft. 8-in. wheels with a pair of carrying wheels at each end fitted with radial axles. In these engines a shortened form of the "taper" boiler is used, and the first of the series will shortly be at work. But a more radical novelty is to follow.

In view of the fact that water-troughs are now laid down at a number of points along the Great Western main lines, Mr. Churchward is of opinion that economy may advantageously be sought in two directions: first, in diminishing the size and weight of the tenders themselves; secondly, in dispensing with the tenders entirely. That is to say, he believes that with the present multiplicity of water-troughs it may be found needless to employ tender engines excepting in case of trains which have very long runs without a stop. On such non-stopping journeys, for instance, as those between London and Exeter, London and Birmingham, and that early expected to come into regular practice, London and Plymouth, tender engines must always be used. But even for these, tenders much smaller than the ordinary Great Western type would amply suffice, carrying abundant fuel, while water can be picked up at so many points *en route* that to haul about huge tanks containing from 4,000 to 6,000 gallons of water is simply a waste of power. The London and North-Western has long managed to carry on its main-line express work with tenders which weigh little more than twenty-five tons loaded, whereas the Caledonian engines, which take on their trains beyond Carlisle, are obliged to have tenders of double that weight because it has not yet been found feasible to equip the Scottish railway with Mr. Ramsbottom's useful invention of the track-trough and tender-scoop. Thus even in point of diminution in tender weight there will be a gain equivalent to conferring on the engine the power of hauling an additional bogie coach. But another large class of express and semi-express trains has also to be provided for, and it is in this connection that the second, and perhaps more interesting, of Mr. Churchward's tank-engine novelties may be found.

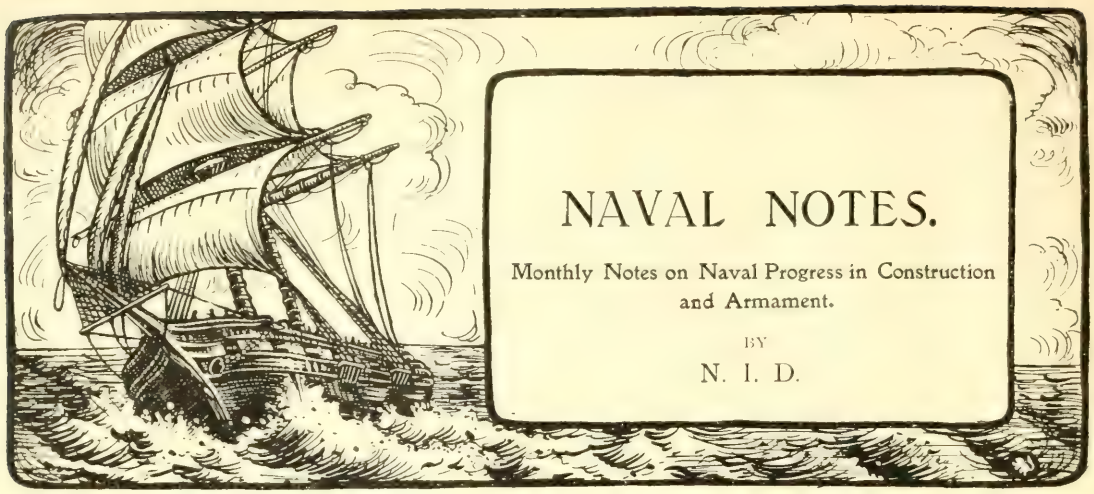
Express Tank-Engines.

It is his idea that trains of this class, such, for instance, as those numerous fast trains which after leaving London, stop at Reading, Didcot, Swindon, and Bath on their way to Bristol; or at Reading, Oxford, Banbury, and Leamington on their way to Birmingham, might be very economically and advantageously handled by a type of tank-engine specially designed and built for that class of service. He is, therefore, about to bring out a new form of ten-wheel engine which may be roughly described as a "taper" boilered "Atbara" converted into a tank-engine; in other words, it will have a leading four-wheel bogie, four-coupled driving wheels 6 ft. 8 in. in diameter, and a trailing pair of carrying wheels. Coal bunkers will be provided capable of providing an adequate supply of fuel, and the tanks will be able to hold an abundant water supply to serve for the run between the respective pick-up troughs. It may be remarked that this class of engine has had an approximate precursor in the latest type built for the London, Tilbury and Southend Railway, in which 6-ft. 6-in. coupled wheels are used; the Great Western engines, however, will have still larger driving wheels 6 ft. 8 in., therefore the largest coupled wheels ever given to a locomotive of the tank type. It is a little curious to find this idea adopted at the present day on the Great Western Railway, for just half a century ago very much the same plan was formed by Mr. Pearson, Locomotive Engineer of the Bristol and Exeter line, which has long formed part of the Great Western system. The germ of the idea was undoubtedly there, but in Mr. Churchward's new design all the faults of the Pearson engines of 1853 will be eliminated, and the engines will be constructed with special reference to existing and prospective requirements.

London and South-Western "Record."

It is the turn of the London and South-Western to contribute the latest instance of railway record-breaking. In its June time-tables it suddenly sprung a considerable surprise on the railway world by taking no less than a quarter of an hour off its best timing between London and Exeter both ways. This brought the transit time down to 3¾ hours as against its previous best of 3½ hours, and against the Great Western's best of 3 hours 35 minutes, the latter, however, having 22½ miles of additional distance, although a generally less severe road. On the 2nd June the London and South-Western ran its inaugural trip from London to Exeter, performing the journey with relative ease in two minutes less than the booked time, although there had been a stay of nine minutes at Salisbury, and delays due to relaying totalling three minutes. Thus the run from London to Exeter was made in 3 hours 13 minutes inclusive, the actual time being 3 hours 4 minutes, the net time, deducting special delays, 3 hours 1 minute, and the net running time, allowing for the loss occasioned by the slowing into Salisbury and starting again from that station, being equivalent to a run without stop from London to Exeter of 2 hours 57 minutes. In other words, had the performance been exactly the same in every respect, except for the Salisbury stop and the casual delays, the London-Exeter run would have been accomplished in 2 hours 57 minutes without running faster at any point than was done on June 2nd. This is an achievement which the London and South-Western authorities may justly regard with much complacence. The engines employed were Mr. Drummond's latest type, having 6-ft. 7-in. four-coupled driving wheels, leading bogie, inside cylinders 18½ in. by 26 in., 1,500 square feet of heating surface, and 175 lb. steam pressure. The engine used between London and Salisbury had Mr. Drummond's water-tube [illegible] the one employed between Salisbury and Exeter was not fitted with [illegible]. The load totalled approximately [illegible] tons behind the tender. It may be mentioned here that Mr. Drummond is bringing out a new express type on the Eastern and South-Western which closely resembles the existing design, but has larger boiler and [illegible] coupled wheels, 6 ft. 9 in. in diameter. This type will be employed on the [illegible] trains of the North Devon section, and should [illegible] model [illegible].

C. J. M.



NAVAL NOTES.

Monthly Notes on Naval Progress in Construction and Armament.

BY

N. I. D.

THE voluminous report of the Naval Reserves Committee, over which Sir Edward Grey was president, is one of the most interesting and valuable Blue Books which has been presented to Parliament for many years. This committee was convened in January last year, to inquire into the methods by which the Navy is manned, and to recommend how the active service ratings might be supplemented by Naval Reserves. The report deserves attentive study by all students of naval affairs, and its recommendations are such as cannot fail to receive support from all thinking men. It was necessary for the Committee to take some point in naval history from which to start in their investigations and they chose the year 1859, when a Royal Commission was appointed for a somewhat similar purpose. At that period the war with Russia had come to an end, and there had been time to examine the lessons to be drawn from our requirements as therein exhibited. The strength of the active list of the Navy stood at 73,104 and the Royal Commissioners recommended that a reserve should be formed numbering 38,000 men. Many years have passed, but the limit then fixed has never yet been attained, and the Committee of 1902 advises that, estimating in the same ratio, our present active list requires a reserve of 61,000, whereas the actual strength is no more than 34,000. The problem thus presented is in effect, how to double the present reserve. It is evident that to do anything of the kind requires time, and the Committee express their opinion that it is of vital importance to maintain a fully trained body of regular seamen commensurate in numbers to the expansion which has taken place of recent years in our naval materiel. For some time to come, then, the growth of the active list must necessarily continue. Although it was almost a foregone conclusion to those who had studied the subject that the Committee would arrive at this decision, an authoritative expression of opinion is very welcome.

Dealing with the augmentation of the Reserve, the Committee set forth in their report a number of methods by which they consider the desired result may be achieved. Circumstances and conditions have so changed during the last half century that proposals and suggestions which might have had a value in years gone by are now entirely out of date. As the Committee point out, the requirements of the Navy have outgrown the power of the Mercantile Marine to supply them. The former have increased while the numbers of British seamen employed in the merchant service have decreased. At the same time the Committee are of opinion that the mercantile marine is still far from being exhausted as a source of supply. And this is especially the case as regards a reserve of firemen. By the last return the actual number of stokers in the Navy was a little more than 20,000, and on the other hand the reserve was a little below 4,000. The Committee are of opinion that the

mercantile marine might be made to yield at least 2,000 more than it does at present. The increase of stokers in the merchant service is noteworthy. There were in 1875 a total of 13,000 men of British birth serving in the mercantile marine as firemen, and in 1901 the number had increased to 23,500. During the same period the active list of stokers in the Navy had increased from 4,200 to 21,400. It does not appear, therefore, that even if the Reserve from the merchant service could be increased to 6,000 that number would be adequate in proportion to the active ratings, and other means must be found for expanding the force. It has been suggested that all the ships subsidised by Government should be required to carry crews composed either of Royal Naval Reservemen, or Royal Fleet Reservists, but the shipowners, while admitting that the proposal is reasonable, explain that they already find a difficulty in providing the proportion of "white firemen" which is stipulated for in the agreements they have made with the Government. They therefore employ Lascars, who are admissible as a substitute by the terms of the agreement, and who, while they are cheaper—an advantage from the shipowners' point of view—are at the same time reported upon very favourably. For this reason the Committee regards both Lascars and Kroomen, who also make good stokers, as material which might be drawn upon in an emergency. It is to be remembered moreover, that to withdraw a large number of white stokers from the mercantile marine on an outbreak of war might have the effect of crippling many of the shipping companies at a time when such a result would have a fatal effect.

Other sources suggested as possible, from which a supply of stokers might be drawn are the private ship yards of the country, where there are many eligible men, who have relinquished a life at sea. In the gas and electric light works, too, there are numbers of men accustomed to the similar work, and it has been proposed to establish naval volunteer corps at such centres. It would be unnecessary with the admirable system of training stokers which has been established at the dockyards to send such men to sea for any great length of time. But the solution of the problem will in all probability be found in the new Admiralty scheme by which every seaman will undergo instruction in the stoke-hold, and in this way an adequate number of firemen will always be carried in the ships.

As regards the seamen reserve, the Committee make further recommendations, and particularly they urge that the fishermen who form such a large proportion of our maritime population should be more largely drawn upon. It is pointed out that in one fishing district alone over 50,000 men are engaged while it yields but 2,000 reserve men. By the offer of higher inducements, and by a moderate relaxation of the standard of training, it is probable that recruiting in this direction might be still further stimulated. The Bill for re-establishing a Naval volunteer corps of seamen and marines has now become law, and before long we may see the growth of a valuable force provided by this means. There is also the new-instituted Royal Fleet Reserve, which the Committee desire should be increased as far as possible, without impairing the principle of continuous service, and with due regard to maintaining an ample supply of competent men for the higher skilled ratings. The growth of this force has been largely accelerated, and there can be no question but that the Admiralty are determined to grapple with this important question of building up an adequate reserve.

GREAT BRITAIN.

Actual progress in construction since my last Notes were written has been steady without any of those incidents which indicate a stage towards completion. With regard to the vessels of this year's programme, the only announcement of importance is to the effect that one of the armoured cruisers of the *Duke of Edinburgh* class is to be laid down at Pembroke Dockyard, and it has been suggested that this vessel will be called the *Duke of York*. Passing from what may be called projected ships, we come to the vessels of the programmes of 1902-3. The battleships of *King Edward VII.* class are arriving at that stage when the date of launching may be expected. We have already reported the [illegible] ought when [illegible] at Devonport Dockyard on July 23rd, and that of the *Dominion* at Barrow on August 28th. The [illegible] dates for launching the *Dreadnought* at Chatham, and the *New Zealand* at Portsmouth, are as announced.

Of the two armoured cruisers the *Black Prince* has

her keel laid at the yard of the Thames Ironworks Company on June 3rd, and she is to be completed at that yard, receiving her guns from Elswick there, instead of going to a dockyard for the purpose. The time allowed by contract for completing this ship is three years. The battleship *Exmouth* has been commissioned and sent to the Mediterranean to take the place of the *Victorious*, as anticipated in these Notes. She will there meet her sister ship, the *Russell*, these two vessels being the most modern battleships on the station. The *Canopus*, battleship, which recently returned from the same station has been sent to Messrs. Laird's yard at Birkenhead, for refit.

Turning to the armoured cruisers, the *Leviathan* has been commissioned for service on the China station, after undergoing certain alterations suggested by experience in her sister ships. Improvements have been carried out in her ventilation below the water line, but the statements that her lower deck guns were to be removed appears to have been erroneous.

An accident on board the *Good Hope* while prize-firing near Gibraltar, on June 9th, was unfortunately the cause of the death of two men and injury to an officer and three others. The official report states that the "anchor bolt of an element in a boiler carried away," whch resulted in an escape of steam into the stokehold.

Several of the smaller armoured cruisers have made their trials, but not with altogether satisfactory results. The *Euryalus* and the *Essex* have returned to the yards for further alterations. On the other hand, the *Monmouth* and the *Berwick* have accomplished successful runs. The *Monmouth* completed an interesting series of progressive speed trials to determine the effect of the use of propellers with increased surface and coarser pitch than in the case of the screws tried in preceding vessels of this class. This vessel is supplied with Belleville boilers. At the eight hours full power run the results were as follows: Vacuum, 26·5 starboard, 26 port; revolutions, 140 starboard, 138 port; i.h.p. 11,049 starboard, 11,140 port, giving a collective h.p. of 22,189; and a speed of 22·8 knots. The coal consumption worked out at 1·97 lb. per i.h.p. per hour. Under more favourable conditions as regards weather it is probable that a higher speed might be attained. Particular interest attached to the relative results obtained with the use of different propellers. Those in the *Bedford* were of the same diameter, 15 ft. 9 in., but the pitch, which in the *Bedford* was 19 ft. 2 in., was in the case of the *Monmouth* increased to 20 ft., and the surface, which in the former ship was 57 square feet, was increased in the latter to 80 square feet. With 16,005 i.h.p. in the *Bedford* the speed obtained was 22·2 knots, and with 22,457 i.h.p. the speed was 22·7 knots; similar horse-powers in the *Monmouth* gave 21·4 knots and 22·8 knots. The *Berwick* attained even better results. This vessel is supplied with Niclausse boilers, and for her full power trial the following are the figures: Vacuum, 27 in.; revolutions, 140·4; collective h.p., 22,680; coal consumption per i.h.p., 1·91 lb.; and speed, 23·613 knots. These are the best results yet obtained, and show that with efficient working of boilers and machinery the *County* class should attain a speed well over 23 knots. The *Monmouth* was built and engined by the London and Glasgow Shipbuilding Company, and the *Berwick* was built by Messrs. Beardmore at Govan, the Niclausse boilers being supplied by Messrs. Humphrys, Tennant and Co., Deptford.

A report from Hong-Kong states that the *Spartiate* made a capital run to that port on her maiden trip. She averaged on the voyage 13 knots, which is her ordinary cruising speed, and expended 2,600 tons of coal on the voyage, which gives an average of 2 lb. per i.h.p. for all purposes. The *Amphitrite* cruiser, on the same voyage at an average speed of 13 knots, consumed 3,900 tons, while the *Blenheim*, cruiser, fitted with Scotch boilers, used nearly 4,000 tons for an average speed of less than 12 knots.

Of small vessels, the *Encounter*, at Devonport, is to be ready for sea in July, 1904. The *Jason*, gunboat, which has been refitted at the Fairfield Company, has carried out her trials. The results of the full power trip give a mean i.h.p. of 5,732, revolutions 341, speed 21·95 knots. The *Spiteful*, torpedo-boat destroyer, has made her first run since being fitted for oil fuel trials, with fairly satisfactory results. The torpedo-boat destroyer *Arun* was launched on April 29th, from the works of Messrs. Laird, at Birkenhead, and torpedo-boat No.113 has been delivered at Sheerness from the yard of Messrs. Thornycroft.

The date of the launching of Submarine A4, at Barrow, was June 9th.

FRANCE.

Some trials recently carried out on the *Henri IV.* have been discussed largely in the press. Two sheep were enclosed in the lower turret of the battleship, while the heavy guns of the superimposed turret were fired, and the autopsy showed that one of them suffered severe injury to the heart, and the other to the brain. The experiments were not, however, considered to be conclusive, and further trials were ordered.

Progress on the armoured cruiser *Léon Gambetta*, at Brest, has been rapid. All her three screws are now in position, and some of the armour, including that for the conning tower, has been fixed in her. The foremast has been stepped.

The armoured cruiser *Marseillaise* has been under trial, and made at her preliminary run 21 knots with her engines developing 20,700 h.p., as against 20,500 contracted for. The coal consumption was 35·84 lb. per square foot of grate per hour, and the quality of coal used was very inferior. On a subsequent trial the engines broke down quite inexplicably, but on an examination being made, it was discovered that a workman had left a hammer in a piston box. The trial subsequently proceeded smoothly.

In the matter of submarines, the French Navy is already well provided, but it is expected that by the end of the year another twelve will have been completed and delivered. These vessels will all be of the

type of the *Naiade*, which was to have been completed in the spring, but which has yet to complete her trials. At Cherbourg four vessels are building. At Cherbourg, besides the *Naiade*, there are three boats building, the *Protee*, *Lynx*, and *Ludion*, which should all be ready this summer; at Rochefort the *Loutre* and the *Castor* are under way; and at Toulon there are six, the *Perle*, *Esturgeon*, *Bonite*, *Tigre*, *Sapphire*, and *Emeraude*, are in various stages of advancement.

Moreover, the hulls of the *Aiguille*, *Grondin*, *Truite*, *Alose*, *Cigogne*, and *Aigrette* are well advanced, but these vessels will not be completed by the end of the current financial year.

GERMANY.

Another new battleship has taken the water. *J*, which was laid down at the Schichau Yard, Dantzic, having been launched on May 16th, received the name of *Elsass* (Alsace). At the same time it was announced that *M*, building at the same yard, would be named *Lothringen* (Lorraine). These vessels are sister ships to the *Braunschweig*, which was described recently in these notes.

An interesting experience was that of the First German Squadron, which, under the command of Prince Henry of Prussia, recently visited the coasts of Portugal. The whole squadron passed through the Kaiser Wilhelm Canal, and this was the first time that the vessels of the *Wittelsbach* class had attempted the feat. They are, of course, heavier and longer than the vessels of the *Kaiser* class, and a good deal of strategic importance appears to have been attached by the German authorities to the successful accomplishment of the passage. At one time, however, it is affirmed, the screws of the *Wittelsbach* were revolving only three feet from the bottom of the Canal.

RUSSIA.

The Russian Admiralty has recently ordered the laying down of two more battleships for the Black Sea Fleet, one at Nicolaeff, and the other at the Sevastopol Admiralty Yard. These vessels are to be of 12,000 tons, but further details have not been reported, although it is believed that the engines will be made by private firms. Three new torpedo-boat destroyers are also reported to be under consideration, to be built by private firms, and to be of the same type as the *Zavietni*, which was built at Nicolaeff. The Russian Black Sea Fleet now consists of seven battleships, the *Potemkin*, *Tri Sviatetilia Rostislav*, *Georghi Pobyedonosets*, *Dvenadsat Apostolov*, *Sinope*, and *Tchesma*, the *Ekaterina* being at present laid up for repairs to her machinery.

UNITED STATES.

The contracts for the building of the *Kansas*, *Vermont*, and *Minnesota* have been awarded to the Newport News, New York, and Fore River Shipbuilding Companies respectively. According to the American [illegible] the hulls of [illegible] would leave [illegible] margin for equipment.

The race in the building of the *Louisiana* and *Connecticut* has been seriously hampered by the strike at the New York Navy Yard, whereby work on the *Connecticut* has been hopelessly delayed. At the time of writing, it does not seem as if the strike would be over very soon, and the battleship will not be finished, to all appearances, until some little time after her sister.

With reference to the failure of the boilers of the battleship *Maine*, it is to be noted that the Secretary of the Navy has let fall some significant remarks from which it has been gathered that the Board is not altogether favourable to Niclausse boilers, and their opinion does not favour the view that the boilers failed from lack of proper feed water and attention.*

The battleships *Rhode Island* and *New Jersey*, now building at the Fore River shipyard, have got forward very fast, and the backing of the forward turret barbette is being set up. This is a wall of ¾-in. steel, extending from the protective deck to and above the main deck, forming a cylinder 26 ft. in diameter. On this steel backing will be fastened the teak wood backing to the armour, and over that the 10-in. steel plates.

The armoured cruiser *Pennsylvania* is to be launched on August 26th next, the ceremony being performed by Miss Susan Quay, daughter of the Senator for Pennsylvania. Other armoured cruisers which are progressing rapidly are the *California* and *South Dakota*, and the *Des Moines*, into which the funnels have already been built, and which is now nearly ready for a dock trial. The *Tacoma* was launched on June 2nd last.

Two torpedo-boat destroyers, the *Dale* and the *Paul Jones*, have been accepted by the Navy Board, and tentatively plans have been drawn up for a "scout" class, similar to those of the British Navy. The gunboats *Dubuque* and *Paducah* are to be built by the Seabury Company of New York.

The gunboats will measure [illegible] in length between perpendiculars and [illegible] extreme breadth. With [illegible] displacement, they will have a total coal bunker capacity of 200 tons. Their armament will consist of six 4-in. rapid-fire guns, one 3-pounder rapid-fire gun, and two Colt automatic guns. Vertical twin-screw, triple-expansion engines will propel them. The contract speed of the gunboats is [illegible] knots. Considering their [illegible] worthiness, with [illegible] displacement, it is to be hoped that the new gunboats are to be a type specially suited and, in fact, intended for service on the shallow rivers of South America and the harbours of the West Indies, where revolutions frequently call for the presence of men-of-war to protect American interests. The date of completion [illegible] months.

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* A further reference to this matter will be found at the end of the "Notes from America."—Ed.

PAGE'S MAGAZINE

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OUR MONTHLY RÉSUMÉ.

LONDON, June 20th, 1903.

The Wage Question.

The labour crisis in the engineering branch of the shipbuilding trade on the North-East coast of England and in Scotland, to which reference was made in previous issues, has passed over for the present. The members of the A.S.E., in their local branches, adopted resolutions disapproving of the arrangement made by their executive officials, that the reductions proposed by the employers should be accepted just now, but that the question of wages may again be raised on the 1st August and not deferred until 1st November, as would have been the case in ordinary circumstances. While disapproving, however, the men in both districts have fallen in with the arrangement. There has been a good deal of talk in trade union circles at the previous rebellion of the engineers in the North against their own executive, and the conduct of the latter has been generally approved. They insisted upon respect for the authority delegated to them by the society, and rightly declared that their duty was to consider and safeguard the interests of the whole society of 94,000 men, not to bow to the violence of the few thousand men in the marine engine shops of the North. Mr. Barnes, the General Secretary of the A.S.E., and Parliamentary candidate for one of the Glasgow divisions in the Labour interests, has been very unfairly treated by Glasgow men in this connection, but he has earned general respect by his firmness and independence.

The North of England and Scotch employers have consented to allow the wage question to be re-opened by the engineers on the 1st of August, because at that date will expire the arrangements made previously with the boilermakers, riveters, shipwrights, carpenters, smiths, etc. And it is proposed that the next arrangement shall be made a sort of general treaty with the whole of the trade unions concerned in the shipbuilding industry. On their part, the trade unions hope that in the interim there may be such an improvement in trade that they may be able to claim a return of the 5 per cent. reduction to which they are now consenting. It is, however, contrary to experience to expect improvement in shipbuilding in the months of June and July. The rule is that contracting is at a minimum in the summer months, when shipowners and shipbuilding "bosses" take their vacations, and when also the men have their spell of holidays. Last summer there was rather an exceptional little run of business, but it would be foolish to look for any repetition of this. Moreover, costs will have to come down a good bit yet before shipowners will be tempted to add more to their fleets than actual necessity compels. It is true that pig-iron warrants have declined considerably during the past month, in sympathy with the appearance of decline in America, but up to the time of writing smelters have not reduced their prices proportionately, because they have been till now fully employed with contracts, and also because (in Scotland, at any rate) they have had labour troubles of their own impending.

Our Monthly Résumé.

Shipping Outlook.

There was in April and May a fair amount of contract-booking by shipbuilders in the North of England, but then the yards there were very bare to begin with. In Scotland there has not been so much booking, but builders there have a larger amount of work carried forward. It is quite possible that more contracts have been booked than have been revealed during the weeks in which the wages controversy was being carried on, but not materially so. Soon after these lines are in print both the trade returns and Lloyd's half-yearly statistics will be in evidence. It will be sufficient to deal with these when they appear, but we do not anticipate that they will be encouraging. The returns of the Labour Department of the Board of Trade are deceptive as to the condition of shipbuilding. They gave the proportion of unemployed in May as 9·6 per cent., but this was only from the reports of certain trade unions, not the whole of them. On the Tyne the proportion was 13·6 per cent., on the Wear 15·8 per cent., on the Tees 18·8 per cent., and on the Clyde 7·4 per cent. The fact, however, is that the percentage of unemployed on new constructional work was much greater, the proportion of the total being reduced by the large amount of repair work that shipowners have deemed it well to have done while the freight markets are so depressed.

The P. and O. s.s. "Palermo."

A new P. and O. liner is always an interesting feature in shipping, and one marked the past month—launched by Messrs. Barclay, Curle and Co., Ltd., Glasgow. It is a large finely-modelled steel twin-screw steamer called *Palermo*, of which the dimensions are: Length, 496 ft.; breadth, 57 ft. 3 in.; depth moulded, 35 ft. 9 in.; and the gross tonnage is 7,600. This vessel has been built to the British Corporation's highest class. A limited number of passengers will be housed under the bridge in commodious, well-appointed state rooms. The officers' quarters are also under the bridge, the crew being accommodated in the poop and fore-castle. There is a complete installation of electric light, and a cellular double bottom is fitted throughout for carrying water ballast. The arrangements for working cargo include ten large steam cranes, four winches, and five derricks (one for taking lifts up to thirty tons) to ensure the most rapid discharge of very large cargoes, and wide-spaced built pillars are fitted in the holds and between decks to facilitate the stowing of goods. The vessel is to be rigged as a two-masted fore-and-aft schooner. The builders construct the machinery, which consists of twin-screw triple expansion engines, with cylinders of 22½ in., 37 in., and 60½ in. by 48-in. stroke, working at a pressure of 185 lb. Steam is supplied by two large double-ended boilers, with a smaller boiler for auxiliary steam.

Admiralty Contracts.

The Fairfield Shipbuilding and Engineering Company, Ltd., Glasgow, completed their contract with the Admiralty for supplying and fitting new engines and boilers to H.M. torpedo-gunboat *Jason*, and the official trials were carried out on the Firth of Clyde. On the low-power trial a speed of 15 knots was attained with 1,185 i.h.p. developed, and on the full-power trial of four runs over the measured mile at Skelmorlie the results were: Mean i.h.p., 5,732; mean revolutions, 341; mean speed, 21·95 knots. In other vessels of this class the speed attained on trial was about 20½ knots, but with about 6,000 i.h.p. The *Jason* is being fitted out complete for the Fleet Reserve. H.M. torpedo-gunboats *Circe* and *Leda* are also at Fairfield getting new engines and boilers.

H.M.S. "Commonwealth."

An important shipbuilding event has been the launch by the Fairfield Company, of the battle-ship *Commonwealth*, the largest warship now afloat. Her tonnage is 16,350 tons displacement, while the largest previous British ship was the *Formidable*, of 15,000 tons. The hull of the *Commonwealth* is of Admiralty quality mild steel. The ram, stem, stern post, brackets, etc., are made of cast steel. The weight of the ram is about 28 tons. There is a double bottom and close sub-division by water-tight bulkheads and flats. The armour is on the Krupp system, manufactured by Charles Cammell and Co., Ltd., at their Cyclops Works, Sheffield. The depth of the broadside armour extends to 22 ft. (instead of 15 ft., as in previous ships), and the thickness varies from 9 in. above the waterline to 7 in. at the upper deck, abreast of the vital parts of the ship, and 3 in. forward and 2 in. at the after end. To afford to the *Commonwealth* the same protection in the old type of armour as is given by the present system, the weight of material necessary would be from two to three times the weight of armour actually placed on the ship. The *Commonwealth* was ready for launching before the end of April, but was kept back in view of the King's visit to Glasgow, in hope that he might be present at the launch. The construction of this vessel up to the launching stage within ten months is a record in ship-building. The *Commonwealth* is the first battleship ever built at Glasgow (though, of course, lots of other kinds of warships have been built there), and she will be the first completed in every detail before leaving the hands of the contractors. Her launching weight was 8,000 tons. The *Commonwealth* was very appro-priately baptised with Australian wine.

Important Amalgamation.

A combine has been effected between Wigham Richardson and Co., Ltd., shipbuilders, Walker-on-Tyne, and C. S. Swan and Hunter, Ltd., shipbuilders, Wallsend. The nominal capital of the amalgamated companies is £1,500,000, divided into 800,000 ordinary shares of £1 each, and 700,000 cumulative 5 per cent. preference shares of £1 each. The consideration to be paid to Wigham-Richardson and Co. for all assets, goodwill, liabilities, and undertaking as per balance-sheet of December 31st last, excepting the amount of cash paid in dividends this year, and the sum of £10,000 necessary for expenses of liquidation, but including shares acquired in the Wingrove Steamship Company, Ltd., in January last, is £304,250 in shares of the new company, namely, £104,250 5 per cent. preference shares, and £200,225 ordinary shares; and the consideration to be paid to the firm of Swan and Hunter, Ltd., is £495,750, partly ordinary and partly preference shares of the new company. One of the purposes of the new company is stated to be to secure controlling influence in other engineering concerns, and with that in view a proposal has been made which will enable it to acquire a financial interest in the Wallsend Slipway and Engineering Company, and to have control over that company's machinery output. The business of Wigham Richardson and Co. is one of the oldest on the Tyne, dating back to the earlier [illegible]. The yard of C. S. Swan and Hunter is one of the best equipped in the country, but has no graving dock.

The Wallsend Slipway and Engineering Company dates from 1871, and is one of the three largest builders of marine engines in the country. The amalgamation will thus be a large and effective one, and probably the intention of a contract for one of the new giant Cunarders has had something to do with it. Swan and Hunter have building berths 800 ft. long, and they built the *Carpathia* for the Cunard Company, but the new leviathans will be larger than that vessel.

New Field for Traction Engines.

One result, interesting to engineers, of the present scarcity of trek oxen, which has been caused by the late war, is the use of traction engines in South Africa for hauling coal from the railway to the mines in cases where the latter are not provided with railway sidings. Formerly this work was done by Boers with ox wagons, and when more normal conditions have been restored the question will arise whether oxen are more economical than the traction engines. The cost of an ox wagon, including driver, native, and upkeep, may be put at £1 per day. It will average 16 miles in 24 hours, so that it will deliver one load of 7 tons per day at a distance of 8 miles, and the freight, therefore, amounts to 4·28 pence per ton per mile. A steam traction engine at 2½ miles per hour covers 20 miles in 8 hours, and the cost for 8 hours is, say, £1 for driver and 10s. for fuel and upkeep. Another 10s. may be added for maintenance of trucks and sundries. As an engine can pull about 20 tons of coal, the cost of haulage is only 2·4 pence per ton mile. In both cases the time occupied in returning with empty wagons is allowed for. There seems, therefore, to be a large field for the use of steam traction in this district for the transport of heavy goods for short distances. At present there are about a dozen engines and 70 wagons employed chiefly in transporting coal.

Motor Vehicles in South Africa.

These are also coming very much into vogue, not only for private use but also for business purposes—for the delivery of newspapers and bread, for instance. There is also a regular service of motor omnibuses running between Johannesburg and some of the suburbs, and there is a municipal motor trolley competing with the venerable Scotch cart in the removal of earth, rubbish, etc. With a view to demonstrating the suitability of motor vehicles for long distance transport in the Cape Colony, the Dunlop Motor Company sent a 12-h.p. Daimler motor lorry from Cape Town to Clanwilliam with a three-ton load. The distance of 156 miles was covered in three days on the outward journey, and 3½ days for the return, with about ½-ton load. The experiment has shown that on account of bad roads and heavy gradients a greater horse-power is desirable for this class of work.

Pegging Fresh Ground.

A number of farms were thrown open by Government for pegging on the 14th April, in the Heidelberg and Klerksdorp districts. In the former district it is stated that 20,000 licences were issued for about 16,000 claims. In the latter district the number of licences exceeded 15,000. It does not follow, of course, that all these claims will be payable, but, as the pegging will in many cases be followed by prospecting, it will help to promote the general improvement which is gradually taking place. The formation of a number of developing syndicates is already causing a demand for materials and machinery suitable for sinking prospecting shafts, and for other preliminary mining work. In a district like this, where the reefs are known to extend over a large area, the limits of which, however, have not yet been traced, the expenditure of time and labour on genuine prospecting work is certainly a gain to the community, even in cases where the country is proved to be barren, because, although the syndicate in that case loses its money, the public gains by the information thus afforded.

Mineral Output of the Transvaal.

The following tables show the output of gold, silver, coal, and diamonds for the first quarter of 1903 :—

GOLD.

Month.	Yield in oz., fine.	Value in £ sterling.
January	201,154	854,440
February	195,655	831,091
March...	219,773	933,541
Totals	616,582	2,619,081

This corresponds with the output in the early part of 1897, so there is still much leeway to make up, but there is every reason to expect not only an increase in each succeeding month, but also an acceleration in the rate of the increase.

SILVER.

Month.	Yield in fine oz.	Value in £ sterling.
January	23,780	2,472
February	22,012	2,330
March...	25,725	2,639

This table includes all the silver produced in the bullion of the gold-mining companies. Formerly the returns were stated in ounces of bullion, including, of course, the gold, silver, and any base metal in the ingots.

COAL.

Month.	Tons.	Value realised at Pit.
		£
January	171,490	68,311
February . ..	154,511	61,480
March...	171,805	68,784
Totals	497,815	198,575

DIAMONDS.

Month.	Carats.	Value in £ sterling.
January	1,060	1,703
February	1,485	1,932
March...	1,319	1,788

Our Monthly Résumé.

Steel Buildings in Johannesburg.

Buildings framed in steel on the American plan are now much in evidence at Johannesburg. One of these is being erected for Messrs. Eckstein and Co., on the site of the well-known "corner house" from which the firm received its colloquial title. This movement in the direction of "sky-scrapers" is due to the enormous value of land in the business part of the town.

Mining in Rhodesia.

The British South Africa Company has recently given permission to owners of gold-bearing properties in Rhodesia to work their ground without proceeding to flotation, on the following conditions, amongst others :—

Ore may be milled from a block of ten claims or less for profit with a five-stamp mill or its equivalent, but the quantity of ore so milled must not exceed 750 tons per month. Under the same limits as to size of block and tonnage for each owner, the ore may be crushed at a customs mill. A royalty of 2½ per cent. on the gold won is payable monthly to the district Mining Commissioner when the claimholder's profit exceeds £100 per month. Gold-mining locations worked under these conditions will not, however, be considered to be finally discharged from the British South Africa Company's interest. As in most quartz mining districts, so probably in Rhodesia, there are many small shoots or patches of gold which may be profitably worked in a modest way, but which are quite unsuitable for exploitation by companies with large capital and expensive management. The above-mentioned relaxations of the Company's conditions are therefore calculated to promote mining work in the country on a practical and profitable basis, on the lines familiar to Australian workers who have tackled similar propositions in their own country.

The Rand Labour Question.

In the course of a reply addressed to an anti-Asiatic deputation, Lord Milner recently reviewed the whole question of Asiatic labour, incidentally remarking that there was not the slightest certainty that Asiatics would be prepared to come there to work in the mines. An interesting side-light is thrown upon this aspect of the Rand labour question by a correspondent in the *Times*, who signs himself "Singapore." "From all that has been written," he says, "on the subject of the importation of Chinese labour into South Africa, one might imagine that the various mine-owners and labour associations have but to beckon to China and she will pour into their compounds a stream of docile, willing labourers, prepared to work at highest pressure under strict control for a moderate remuneration, and at the end of their contract time to return to China, equally under surveillance with the hard-earned cash presumably on or about their persons. That this is a prospect likely to prove alluring to Chinese may at least be doubted. The most cursory glance at the history of emigration from China will show that what the Chinese emigrant most keenly desires is freedom to live his own life, earn his money by his own methods, and cultivate his own vices, all to a higher perfection than can be attained in China. It may be predicated that no Chinese will leave China unless with the hope of living a happier life out of his own country than he can hope to attain in it. The emigrant regards emigration as he regards any other gamble before entering upon it—he weighs, that is, probable chances of success against risks of failure, puts down the stability of the foreign Government as a set-off to a bad or indifferent climate, balances the actual existence of wife and children in China against the possibility of a temporary union in the land of the foreigner, and contrasts the opportunities open to energy and initiative in a new country with the paralysing checks upon enterprise in his own land of ancestor worship, tradition, and custom. But above all things he desires a free hand. He will not object to a contract to labour for a particular employer, especially in countries where his own race is numerous already, and breach of contract is difficult to visit upon the defaulter; but his contract is merely a means to an end, which is, in the enormous majority of cases, to accumulate wealth and enjoy prosperity in a country where these cannot be snatched from him at a moment's notice, and, as a pious hope dimly foreseen, to return to China to end his days in peace, supported by the proceeds of investments which he has been careful not to make in China. The opening provided by the gold-mining industry of South Africa is, indeed, one which might appeal to any class of native which desired moderate, though at the same time certain and speedy, profit; but the complete elimination of chance from its operation will not appeal to the gambling spirit in the average Chinese emigrant."

North of England Institute of Mining and Mechanical Engineers.

The general meeting of the North of England Institute of Mining and Mechanical Engineers at Keswick, extended over three days, and commenced with a visit to the Threlkald Quarries of the Threlkald Granite Company, Ltd., followed by an inspection of the water-screening chamber of the Manchester Corporation. The following papers were either read or taken as read :—(1) "Hematite Iron Ore Deposits and Hematite Mining in West Cumberland," by Mr. W. E. Walker; (2) "Iron Ore Mining in Cumberland," by Mr. J. M. Main; (3) "The Geology of the Lake District," by Mr. J. Postlethwaite; (4) "Description of the Ore-washing Plant at Greenside Mine," by Mr. W. H. Borlase; (5) "Granite Quarrying, Sett-making and Crushing, and the Manufacture of Concrete Flags and Granitic Tiles," by Mr. George H. Bragg; (6) "Mines and Quarries of the Lake District," by Mr. John C. Wasley; (7) "Ambulance Instruction at Mines," by Mr. William Leck, H.M. Inspector of Mines; (8) "The Use of Carboniferous Plants as Zonal Indices," by Mr. E. A. Newell Arber; (9) "The Gypsum of the Eden Valley," by Mr. D. Burns. An excellent programme of visits to mining centres was arranged, and the interest of the papers was greatly enhanced by the fact that for the most part local subjects were dealt with by local men.

"Wireless" Telegraphy.

A significant reply was that given by the Postmaster-General in connection with criticisms raised in the course of the debate on the vote for the Telegraph Service. After mentioning the assistance which had been rendered to Mr. Marconi by the Post Office in earlier years and explaining their attitude of recent years, Mr. Chamberlain proceeded :—At present they knew very little about "wireless" telegraphy. They knew very little of the conditions under which "wireless" telegraphy would have to be worked. In most countries the Post Office was in the position of a monopolist; but in this country the monopoly of the Postmaster-General did not cover

communications with a foreign shore or outside the three-mile limit. The Post Office, therefore, could not strangle the invention even if it wanted to. Their business communications had not been with Mr. Marconi, though personally his relations with that gentleman had been most friendly. They had been dealing with the company which possessed the inventor's rights. The company did not ask merely for what the cable companies had. They asked for an exclusive right to work "wireless" telegraphy in this country, and they asked for permanence. He could not give them either. He said he would give them a private wire at Poldhu; and when they applied for it they had that private wire, and they had had it for some time past. There was no difficulty at any time about the company's having their private wire on ordinary terms, or obtaining delivery of any messages sent to them from any point in this country, or having messages received at Poldhu put on the Post Office wires. But they asked the Post Office to become their agents for the collection of messages to be transmitted by their wireless system in the same way that anybody could hand in a message at any post office to be transmitted by the cable companies. He wrote explaining generally the terms on which he was prepared to act, and laid down certain conditions he would have to enforce in order to prevent interference with the Admiralty for strategic reasons, and to safeguard national interests. He further said they must satisfy his technical officers of what was disputed by him, namely, that the company were in a position to carry on their business and transmit messages from one side of the Atlantic to the other. That letter was written on March 31st last, and he was still waiting for a reply. He did not complain of the delay in the least; but he did complain that the delay should be attributed to the Post Office.

During the progress of a demonstration of "wireless" telegraphy by Professor Fleming at the Royal Institution, Mr. Nevil Maskelyne, from an outside source, succeeded in causing certain interruptions, and arrived at the conclusion that "a simple untuned radiator upsets the tuned Marconi receivers," but Professor Fleming, in a letter to the *Times*, describes the assumption that he was using a syntonic apparatus as "gratuitous and erroneous."

The Naval Architects.

The Institution of Naval Architects held its summer meeting this year in Ireland, the Lord Mayor of Belfast (the Right Hon. Sir Daniel Dixon, P.C., D.L.) welcoming the members to that city at the opening of the Conference, on the 23rd ult. "Belfast Harbour and its Development," by Mr. C. F. L. Giles, M.Inst.C.E., was appropriately among the first of the papers down for discussion, other contributions, including "Fast Coaling Ships for our Navy," by Mr. E. H. T. d'Eyncourt, and "Mercantile Cruisers fitted with Housing Propellers," by Mr. James Hamilton (member of Council). On Wednesday the papers included "Cross-Channel Steamers," by Professor T. H. Biles, LL.D., (member of Council); "Registered Tonnages and their Relation to Fiscal Charges and Design," by Mr. James Maxton; and "Some new types of Superheaters," by Professor W. H. Watkinson. Some pleasant social functions were arranged, and visits were paid to the shipyards and marine engine works of Messrs. Workman and Clark, and Harland and Wolff. On the following day (the 25th ult.) the members journeyed to Dublin by special train, the programme including a garden party at the Vice-Regal Lodge by the special invitation of the Lord-Lieutenant, and a ball at the Mansion House given by the Lord Mayor of Dublin (Mr. T. C. Harrington, B.L., M.P.). When the members settled down to business on the following day the Hon. C. A. Parsons, F.R.S. (member of Council), read a paper on a subject which is peculiarly his own, viz., "The Marine Steam Turbine and its application to the Propulsion of Vessels," Mr. J. P. Griffith, M.Inst.C.E., following with a description of the Dublin Harbour Works. The summer meeting terminated on the Saturday.

Telegraph Conference.

During the month the ninth Quinquennial Telegraph Convention has been proceeding at the Examination Hall of the Royal College of Physicians and Surgeons, its object being "the amelioration of international telegraphs in the interest of the public." The proceedings of the Conference have been private, but a brief official report of the opening states that "in welcoming the delegates the Postmaster-General referred to the importance of the matters which they had met to discuss and wished them success in their labours. Dr. Hennyey de Hennye, the principal delegate of the Hungarian Administration, responded in eloquent terms to the address of the Postmaster-General, and, as the representative of the Administration which last entertained the Conference at Budapest, gave a résumé of the events affecting the International Telegraph Convention which had occurred since the last conference. Monsieur Delarge, the senior delegate of Belgium, and Doyen of the Conference, followed with a friendly speech; and Monsieur Pereira, the delegate of Portugal, also thanked the Postmaster-General for the welcome which he had extended to the delegates, and joined in the wish that the result of the conference would be beneficial to the telegraph world. Mr. J. C. Lamb, C.B., C.M.G., the principal delegate of Great Britain, was chosen President of the Conference, and Mr. John Ardron and Mr. P. Benton, Vice-Presidents. The following Presidents of Committees were appointed: M. Delarge (Belgium). M. Sydow (Germany), M. Neubauer (Austria), and M. Bordelongue (France); and these gentlemen are to be assisted by the following Vice-Presidents: M. Gvozditch (Servia), M. Sevastianoff (Russia), M. Pop (Netherlands), and M. Pereira (Portugal). The secretarial duties of the Conference are carried out by the International Telegraph Bureau of Berne, which is represented by M. le Colonel Frey, the distinguished Director of the Bureau, M. Eschbaecher, the Vice-Director, and M. Homberger. On the nomination of the President, Mr. N. Hautrive, Mr. J. I. De Wardt, and Mr. J. F. Lamb, of the General Post Office, London, were appointed as the British Secretaries to the Conference.

The following States are represented:—

Argentine Republic, Austria, Belgium, Bosnia-Herzegovina, Brazil, Bulgaria, Cape of Good Hope, Ceylon, Commonwealth of Australia, Crete, Denmark, Dutch East Indies, Egypt, France and Algeria, Germany, Great Britain, Greece, Holland, Hungary, India, Indo-China, Italy, Japan, Luxemburg, Madagascar, Montenegro, Natal, New Caledonia, New Zealand, Norway, Persia, Portugal, Portuguese Colonies, Roumania, Russia, Senegal, Servia, Siam, Spain, Sweden, Switzerland, Tunis, Uruguay, and the United States.

The social functions connected with the Conference have included a dinner given by the Postmaster-General, and another under the auspices of the Telegraph Companies. On the 11th of June a highly successful Concert in honour of the foreign

delegates was given at the Albert Hall in the name of the President of the Institution of Electrical Engineers. The members have been received by His Majesty the King at Windsor, and have also been entertained at the Mansion House.

Significant Destructor Souvenirs.

At the opening of the new Horsfall Refuse Destructor at Grimsby some significant presentations were made. At a critical moment of the ceremony, the Mayor, turning to Councillor Pickwell (Chairman of the Destructor Committee) said :—"I have much pleasure in handing you this pair of scissors with which to declare the Destructor open, and to acknowledge your very hard work during the years you have been on this Committee, to watch and look after the interests of the Borough of Grimsby in the building of this Destructor. I am certain that it will be of benefit to the town, and I hope you will live many years in health and prosperity, and be able to look upon the past with pleasure." We were somewhat puzzled as to the proposed application of the scissors, but on reference to the *Grimsby News*, observe that Mr. Pickwell "cut the tri-coloured ribbon stretched across the entrance and declared the works open." This ingenious arrangement was possibly intended to indicate a cutting-down of expenses on the Silhouette plan, for we observe that the scheme includes a house fitted with a mortar mill, clinker crusher and screens, intended for the conversion of the residue into a marketable commodity useful for concrete floors and foundations. The Chairman of the Committee was also presented with a pencil, and to the Borough Surveyor (Mr. H. G. Whyatt) a matchbox was handed, bearing a suitable inscription. The destructor has four cells capable of burning forty tons of refuse per day.

The Iron Ore Deposits of North Lapland.

It is expected that the railway connecting the Gulf of Bothnia with the Atlantic from Lulea to Narvik close to the Russian frontier will ere long be opened throughout its whole length. The railway is built partly by the Swedish, partly by the Norwegian Government, and especially in order to facilitate the exportation, *via* Narvik, of the immense quantities of magnificent iron ore found at Kirunavaara and Gellivara. Through alleged bad management and over speculation a crisis has for some time been impending with regard to these ironfields. Last spring the Government proposed to secure them for the State, mainly with a view to prevent their passing into foreign hands, which Swedish public opinion seemed to fear might have dangerous political consequences. This proposal was, however, rejected by the Riksdag. Another attempt to save them for Swedish capital has now encountered the same fate. The Grängesberg Society, which was originally formed by the initiative of Sir Ernest Cassel, and includes a great many of the iron works of Central Sweden among its shareholders, offered to buy the ironfields on certain conditions. Amongst these the essential stipulation was that the State should give the society a loan for twenty millions of crowns, which the Riksdag would not consent to. As it seems, however, to be of vital importance to the iron industry of Sweden that Kirunavaara and Gellivara should be controlled by Swedish capital, a way will almost certainly be found to avert the much dreaded calamity of their passing into Russian or German hands.

Admiral Melville on Warship Construction.

Rear-Admiral G. W. Melville, chief of the bureau of steam engineering, U.S.A. navy department, has written an article for the *Philadelphia Ledger* on the tendency in warship construction. Among other things he says :—"When will the limit of size be reached, if each increase in displacement has made the ship a better fighting machine? The limit of size will not be reached until the demand of the engineer for space and weight for machinery is given the same recognition that is accorded the ordnance and hull experts. It is certain that warships must be made even larger, and in accordance with this belief the British admiralty has projected battleships of 18,000 tons displacement. Boilers are still made too frail, since their tubes are too thin, their casings too light, and their drums too small. This shaving in weight of important parts also extends to the engine-rooms, for engine frames are not as strong as they should be. The tubes of condensers are too contracted: the piping is too complex by reason of the crowding of auxiliaries, and altogether there is a forcing of appliance into contracted spaces beneath the protective deck that results in excessive repair bills and long stays in port. An increase in weight would keep the ships longer at sea, and it would seem that this reason alone would correct the evil of installing light machinery. Against the vigorous and determined protest of the engineer, the ships seem to be built for the hour of the contractors' trial, rather than for the day of battle. From the standpoint of the quarterdeck, the modern battleship may seem to possess endurance and strength, but from the view of those beneath the protective deck this strength is more apparent than real. It will be found in the next naval war that in the distribution of weights allowed in the construction of a modern war vessel, there has been too great a tendency to sacrifice the efficiency of the machines that are not within sight of the inspection officer, in order that the appliances above the protective deck may be made more efficient and that even luxuries may be secured.

"It requires a resourceful and intelligent man to stand behind the modern gun, but it requires equal intelligence and skill to stand in front of the modern boiler or operate a high-speed marine engine. It will neither promote naval efficiency nor inspire confidence for either the man behind the gun or the man at the throttle to know that the weak line in the naval chain is contained within the engine room, where the smallest factor of safety has been assigned to the working parts, and where the appliances must be subjected to the severest and most continuous strain.

"The larger the [illegible] of the battleship the more satisfactory will be her performance, for every increase in displacement means a proportionate and relative [illegible]"

AMERICAN RÉSUMÉ.

NEW YORK, June 20th, 1903.

The Problem of the Marine Boiler.

The failure of the boilers installed in the battleship *Maine* has been the cause of much apprehension with regard to the advisability of continuing the use of the Niclausse boiler in the Navy. Admiral Melville has insisted for a long time that it is not adapted for sea service, and the Bureau of Steam Engineering has invited competition among boiler designers in the hope of securing a new and better type for marine work. The Niclausse type has already been installed in a half dozen or so of our war vessels. England has it in two gunboats, and contracts have been given for two battleships and several armoured cruisers. As it is a French invention it naturally has been installed in a large number of the warships of that country. Germany and Russia also have a number of vessels using the Niclausse boiler, but the Russian Government has decided not to employ it hereafter. Its extended use may be accounted for in that it possesses certain distinct advantages not embodied in others of the present day, chief of which are its high power capacity for limited space required, and an economical fuel consumption. Its great drawback in the opinion of the Bureau of Steam Engineering, which has been conducting a thorough examination of various boilers, is the tendency, on account of its peculiar construction, for the water to leave the tube ends when the boilers are forced, leaving them exposed to the danger of weakening by bending and even burning out. Moreover, this liability is greatly increased by the rolling and pitching of the vessel in heavy seas.

The examiners were convinced in these points of deficiency after the investigation of the *Maine* boilers. A number of tubes were found so badly damaged that they will have to be renewed, many of them having been warped out of position from $\frac{1}{2}$ in. to 6 in., and others having burst as a consequence of being burnt. It is estimated that the proper repairs to fit the battery for another trial will cost from $10,000 to $15,000, which includes the replacing of damaged tubes, gauges, glasses, etc., and the provision of a device operating from the deck, whereby any boiler may be cut out in case of accident. The report of the Edwards Board, made a few months ago on the problem of the water-tube boiler, urges the subordination of attempts to decrease weight and size, to safety and the securing of a type that may be depended upon for endurance under long continued forcing. It is emphasised that efficiency in the boiler equipment is quite as important as efficiency in the guns and armament, and that equal care should be exercised in testing before installation and in proper handling thereafter. In suggestions for a new type, long steaming qualities are advised with high power, even at the expense of space or greater first cost. A preference is expressed for an American design, if possible a modification of some land type now in common use, the advantage being that in time of emergency men might be recruited whose familiarity with shore practice would prepare them, with but little additional training, for the naval service.

Some American-built Turbines for England.

The steam turbines which are being built by the Westinghouse Electric and Manufacturing Company for the Metropolitan District Railway Company of London, are the largest steam turbines ever made, and the most powerful single cylinder engines of any type in the world. Their normal capacity will be 5,500 kilowatts, but they will be capable of carrying an overload of 50 per cent., giving for each unit a maximum output of 8,250 kilowatts, or about 11,000 h.p. Notwithstanding this enormous capacity, the dimensions of these engines are only 29 ft. in length by 14 ft. in width and 12 ft. in height, the overall length of turbine and alternator being 51 ft. and 9 in. The steam pressure will be 165 lb. per square inch, and the speed 1,000 revolutions per minute.

Comparative Test of Oil and Coal as Fuel for Locomotives.

An interesting comparison of costs with the use of oil and coal as fuel for locomotives, where both were operated over the same road and under very nearly the same conditions, is given in the last issue of the *American Engineer and Railroad Journal*. The tests were made on the Boston and Maine railroad between Mechanicsville and East Deerfield, a distance of eighty-five miles. The figures were furnished by Mr. Henry Bartlett, superintendent of motive power, and since the tests were conducted for the purpose of determining the company's policy with regard to the continuance or discontinuance of oil as a fuel, they may be accepted as reliable. The engines were of the same pattern, and generally identical in dimensions, with only such differences in arrangements as were necessary for burning oil or coal. They were simple engines with cylinders 20 in. by 24 in.; driving wheels, 57 in.; weight on drivers, 121,000 lb.; total weight, 141,000 lb.; weight of tender, 80,000 lb.; total weight of locomotive and tender, 221,000 lb.; fire box, 41¼ in. by 102 in.; total heating surface, 1,856 square feet; total grate surface, 29·6 square feet; steam pressure, 200 lb. per square inch. In all thirty-eight trips of the oil engine were reported upon, and twenty-three of the coal engine. The following were the principal results deduced, the cost items being based on oil at three cents per gallon, and coal at $3.45 per ton.

	Oil.	Coal.
Average tons hauled per trip ...	802·13	781·83
Average cost per trip ...	$26.61	$19.94
Average cars hauled per trip ...	28·30	27·22
Average cost per car mile... ...	$.01102	$.00862
Average cost per ton mile... ...	$.00039	$.00030

American Résumé.

A New Oil Engine.

The technical press during the last month has been giving some prominence to a new oil engine, the striking features of which are its ability to burn the heaviest and cheapest oil, to burn it gradually rather than explosively, and at such a low temperature that little or no jacket water is necessary, thereby diminishing the waste of heat energy in jacket water; and to afford its own ignition by compression of the air, after running conditions are established, by a temporary use of an electric sparking device. The engine is the invention of Mr. Oscar P. Ostergren, of New York, a mechanical engineer of some note as a steam engine designer, and one of the first to produce liquid air in commercial quantities. It is a single-acting vertical engine of the two-cycle type, the down-stroke being the working one, and has an admirable provision for scavenging the cylinder with clean air between working strokes. At the time of each impulse on the upper face of the piston the lower face is compressing a charge of fresh air, which at the end of the stroke is admitted above the piston just at the instant of exhaust of the burned gases, completely removing all traces of the latter. The air receives a second and much higher compression on the up-stroke, and is thereby raised in temperature to a point sufficient to ignite the oil as it is sprayed into the cylinder for the ensuing down-stroke. The oil charge is impelled into the cylinder by an auxiliary pump, operated by a cam on the engine shaft, which compress a small portion of the air taken from the cylinder to an even higher degree than that left in the cylinder, so that when admitted behind the oil charge, the latter is injected gradually as a spray into the head end of the cylinder, where it is burned as fast as it is received, producing the expansive working force. The oil for the next charge is introduced to the retaining chamber at the head of the cylinder by the suction produced as the auxiliary pump moves to its lower position at the end of the down-stroke of the engine piston, and is prevented from returning to the supply tank by three little check valves in series.

The engine is started after a period of rest by admitting compressed air from a storage tank to the upper face of the piston, the oil charge being injected at the same time, and the burning effected for a few strokes by a sparking plug. After running conditions are established, the metallic parts having become hot enough to sustain ignition, along with the heat in the compressed air, the spark may be discontinued and the air tank re-charged at the expense of the air compression in the cylinder, which requires but a few strokes. A check valve in the inter-communicating air pipe prevents the air from flowing back into the cylinder until such time as it may be required again for the starting of the engine.

The engine will be built in many sizes, from very small ones for the driving of automobiles, launches, etc., to very large ones for pumping stations, factory power plants, and in short for any station now filled by steam engines.

Iron and Steel.

There have been no advances in prices in any of the metal commodities during the past month. On the contrary pig iron, old materials, and tin have declined slightly. All other products—billets, rails, finished iron and steel, and the common metals, with the exception of tin, have maintained a uniform price. Foreign foundry iron has ceased to be a factor in the market, as the cheaper grades will meet the needs of but a limited number of consumers, and the higher grades cannot now compete with equal domestic metals. It seems unlikely that the German syndicate will longer attempt to retain its foothold here. The May production of cast iron has even run ahead of the tremendous output of April. Consumers are still holding off, however, and their attitude appears to be justified, as prices are continually receding from the unnaturally high prices that have been prevailing.

Some are needlessly alarmed at this drop in the price of pig iron, as they do not seem to consider that still it has not reached its normal value. The high figure that has marked the past year may be directly attributed to conditions which prevailed during that period, *i.e.*, scarcity of cars and inadequate facilities for transportation generally, and shortage of coke and coal attendant throughout the recent anthracite miners' strike. These same causes were responsible for the large importation of pig iron during the last few months, and, as they are now mostly removed and normal conditions nearly resumed, it is not strange that importation has decreased. In connection with the matter of importation, it is of interest to state that an important legal decision was handed down in the United States Court of Appeals, May 7th, which sustains the contention of the plaintiffs, Messrs. O. G. Hempstead and Son, that tungsten ore should be admitted free of duty.

In spite of the labour troubles a good and increasing amount of structural material is being produced. The steel rail business is likely to be benefited by the prospect of several large orders from a number of railroads, to run into next year. It is reported that certain large manufacturers of agricultural implements are making foreign connections with a view to importing special steel [illegible] for export. Chicago reports a good demand for [illegible] and domestic billets, with [illegible] for the market to become a trifle firmer, and also reports some increase in the demands for [illegible] and soft steel bars.

GERMAN RÉSUMÉ.

BERLIN, June 20th, 1903.

Fifth International Congress for Applied Chemistry.

The Fifth International Congress for Applied Chemistry is being held during the present month at Berlin. After taking place every two years since 1894, when the first meeting was held at Brussels, this assembly has now become triennial. More than 1,200 members are recorded in a preliminary list lately published, and the total number is estimated at about 1,500. As the most prominent exponents both of science and industry participate in the meetings of the Congress, the latter is deserving of more than a passing interest.

Iron for Railway Construction.

In a paper on the "Progress of Iron Industry in connection with Railway Construction," Dr. A. Hartmann drew attention to the enormous advance brought about in the refinery of iron by the Bessemer process, which was first introduced into practice in 1862. Modern metallurgy has ample means of imparting to rails any strength desirable, whereas another important issue in connection with the manufacture of railway iron, viz., its hardness and resistance to the constant wear and tear, is far from being satisfactorily solved. Recent tests made by the author have shown that the mean annual surface wearing of a rail is about 21 square millimetres, that is to say, that 1 millimetre in height will be worn out at the head of a normal rail in three years, the consumption at the joints being, however, very much greater with current superstructures. The loss by wear and tear amounts to no less than 19,000 tons of rail per annum in Germany. In spite of this continual consumption, it would be possible to warrant a thirty years' life to Bessemer rails, even on highly frequented lines, but for the actual imperfect constructions of joints, which will result in a premature destruction of the rails. In addition to first-class material, the shape of the rails appears to be of utmost importance, greater lengths being favourable also on account of the diminished number of joints. It may be mentioned that modern rolling mills allow of rails as long as 100 metres being made. Endeavours are being universally made to enforce railway tracks, but the means of obtaining this are so far the subject of controversy. On the one hand, the result is aimed at by enforcing the rails, whereas other experimenters are increasing the number of sleepers. The author thinks that the best way would be to enforce *all* the parts of the track in a harmonious way.

As regards the problem of the material most suitable for sleepers, iron sleepers are now sufficiently improved to make superstructures with iron cross-sleepers, as a rule, at least as economical as superstructures with wood cross-sleepers. A more general use of iron sleepers would be desirable also on account of the ever-increasing devastation of forests, and the climatological disadvantages attendant thereupon.

Aluminothermics.

Dr. Hans Goldschmidt's lecture on "Recent Progress in Aluminothermics" aroused universal interest. The author has devised a process for *producing high temperatures* by means of burning aluminium. This process may be used to prepare metals in a pure state, but the most important applications of "aluminothermics" are welding processes, such, for example, as the welding of tramway rails. Thermite has, of late, assumed an important *rôle* in repairing ships; the author illustrated by projections on a screen a number of repairs made of broken parts of ships, which it would have taken months and cost thousands of pounds to replace, whereas the cost of this repair, made in a few hours, was only a few pounds. It may be interesting, in this connection, to give some details as to the welding of the broken stern-post of the steamship *Scvilla* of the Hamburg-American Line. After removing the helm, the iron at the fracture was brought to a red heat and surrounded with a double-walled, tight-fitting case, the walls of which were separated by a layer of graphite or asbestos. Chemically pure iron placed in a crucible was melted by means of thermite and eventually poured out into the case round the fracture. A bore made throughout the fracture showed all the parts to be well connected. A novel application of thermite is the improvement of cast iron, by producing the reaction below the surface of the liquid metal, when the pores of the cast will be eliminated.

New Melting Process.

Another melting process has lately been brought out by the Köln-Müsener Bergwerks-Aktien-Verein; it is intended for perforating or melting down hardened parts in an unusually short time. The process consists in heating with an oxy-hydrogen flame the portion in question to an extreme white heat, when oxygen at a high pressure is blown against it. The heat of combustion will yield the amount of heat necessary to melt the adjoining parts, the high pressure carrying off the molten masses with greater velocity than the heat is conveyed from them. The oxygen thus obtains unceasingly renewed working points, the oxydised material not becoming cooled by the stream of gas. As the high pressure will throw the molten masses out of the holes formed, it is possible to melt in either a horizontal or vertical direction. A cold iron or steel ingot, about 400 millimetres in length, may thus be perforated in about three minutes. The new process has been found to be particularly suitable for opening the tap-holes and blast-nozzles of blast furnaces, as it will perform in a few minutes an operation that would otherwise require hours or days.

Electric Lighting of Railway Trains.

German railway authorities have long been opposed to adopting electric lighting for their trains, and it is

gratifying that at last a step has been taken with a view to replacing the existing inadequate gas lighting scheme by a more modern system. The D trains circulating between Berlin and Hamburg have for a short time been equipped with an electric lighting plant installed by the Storage Battery Company, Berlin-Hagen i/w., according to the designs of the Prussian Minister of Railways. The current is generated by a dynamo located on the locomotive-boiler and driven by a 20 h.p. De Laval steam turbine, the wheel of the turbine making 20,000, the dynamo 2,000 revolutions per minute. A storage battery is placed underneath each carriage, all the batteries being connected in parallel to the dynamo. Each compartment contains in addition to the ceiling lamps, reading lamps capable of being switched on or off by the passengers themselves. In order to charge the accumulators, the tension of the dynamo is temporarily increased, an iron wire resistance, surrounded by a glass bulb containing hydrogen, being connected to the terminals of each lamp, so as to prevent any fluctuations of the light. The iron wire is brought by the current of the lamps nearly to a red heat, when the slightest increase in the intensity of the current will suffice to augment the resistance of the wire to such an extent that variable [illegible] not produce any appreciable fluctuation in the luminous intensity.

"Wireless" Telegraphy from Running Railway Trains.

"Wireless" telegraphy is making rapid advances in Germany. The daily papers, some weeks ago, discussed a new system devised by Herr Rühmer, which, at the present moment, is receiving attention by German military and naval authorities. No particulars as to the principle on which this scheme is based are so far forthcoming; it seems, however, that selenium cells play in this system a similar part to their *rôle* in the inventor's "wireless" telephony devices. Now we learn that the Wireless Telegraphy Company, System Braun-Siemens, have lately made "wireless" telegraphy experiments from moving trains on the Berlin-Zossen Military Railway, these experiments being attended by representatives of the military authorities. These tests have been a perfect success, a lively interchange of messages passing between Marienfelde and Rangsdorf stations and the moving train. Evidence has been given of the absolute reliability of the transmission.

COMING EVENTS

July.

1st.—Colliery Appliances Exhibition opens at Agricultural Hall.—Staffordshire Iron and Steel Institution: Visit to the G.W.R. Works at Swindon.

2nd.—Institution of Mining Engineers: General Meeting at 11 a.m., in the rooms of the Geological Society, Burlington House.—Midland Counties Institution of Engineers: Meeting in London.

3rd.—Institution of Mining Engineers: General Meeting at 10.30 a.m., in the rooms of the Geological Society, Burlington House.

4th.—Institution of Mining Engineers: General Meeting, Visits to Works, etc.—Midland Counties Institution of Engineers: Meeting in London.

8th.—Colliery Appliances Exhibition at Agricultural Hall, last day.—Annual Conference of the Municipal Tramways Association opens at Glasgow.

10th.—Civil and Mechanical Engineers' Society. Visit to Messrs. Thornycroft's Works at Chiswick, at 5 p.m.

11th.—Midland Counties Institution of Engineers: Meeting at Midland Institute, Leeds.

13th.—Birmingham Association of Mechanical Engineers: Annual Excursion.

16th.—British Society of Mining Students: Annual Meeting in the rooms of the Geological Society, Manchester.

17th.—Ironmongery and Electricity Exhibition opens.—British Society of Mining Students: Annual Meeting (continued) in rooms of the Geological Society, Manchester.

18th.—Meeting of the North of England Institution of Mining and Mechanical Engineers.

28th.—Ironmongery and Electricity Exhibition, last day.

31st.—Institution of Mechanical Engineers: Meeting at Leeds.

August.

1st.—North of England Institution of Mining and Mechanical Engineers: Annual Meeting.

13th.—Mining Institution of Scotland: General Meeting at Hamilton.

15th.—Opening Municipal Electrical Convention at Sunderland.—Institution of Junior Engineers: Summer Excursion to Sheffield.

16th.—Municipal Electrical Convention: Meeting at Newcastle-on-Tyne.

17th.—Municipal Electrical Convention: Meeting at Middlesbrough.

18th.—Annual General Meeting I.M.E.A. at Sunderland.

NOTABLE BRITISH PAPERS OF THE MONTH.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

THE DESIGN OF PERMANENT-WAY AND LOCOMOTIVES FOR HIGH SPEEDS.

THE following paper was read at the recent Engineering Conference by Mr. James Charles Inglis, M. Inst. C.E. :—

The impact on permanent-way arises necessarily from two sources :—

1. The condition of the permanent-way itself, and
2. The design of the locomotive.

The increase in the train mileage, at any rate on British railways, is mostly on long-distance traffic. This generally means heavy trains and heavy axle-loads, hauled at a relatively high speed.

The strength of the permanent-way and the condition of the road-bed are of the first importance, as when the permanent-way is of a relatively light structure, or the road improperly packed and badly drained, there can be no satisfactory running at high speed. Indeed, with the increase in high-speed traffic there comes a more imperative necessity to give greater attention to these matters, as well as to the alignment of the lines, and the super-elevation of the outer rail in curves, than heretofore.

The next point is equally important—viz., the maintenance of a standard gauge width. The author has had instances of new roads laid in straight line where the sleepers had not been adzed, and the chairing had been done by hand, and it was found that the gauge varied to the extent of $\frac{1}{4}$ in. to $\frac{3}{16}$ in. Although the permanent-way was of a heavy section, the joints good, and the packing and ballasting properly done, the running was not satisfactory, so much so that the whole length so laid was regauged, and the traffic again sent over it at high speed, with the result that the engines and carriages ran comparatively quite smoothly.

POINTS FOR SMOOTH RUNNING.

Reduction of impact at switches and crossings and smooth running through junctions are largely brought about by attention to the following points :—

1. Making curves of easy radii.
2. Using long switches at diverging and converging points and avoiding short rails.
3. Working to a uniform gauge and giving special attention to levels.
4. Restricting the speed on curves.

As crossings and junctions are very frequent in railways in Great Britain, attention to those points solves a considerable part of the question of smooth running.

Swinging and swaying arise chiefly from suddenly changing curvature, and, as this depends on the laying out of the railway and the land at the disposal of the company, cannot be altered very much in the case of existing railways. Of course, in new lines there is no general reason why this disadvantage could not be met in the original laying-out of the line.

On lines with expresses running up to 60 miles per hour, no curves should be of less than 40 chains radius. I am aware that on many routes with high-speed traffic the curves are sharper than this; but, all the same, I think a speed of 60 miles per hour on curves of less than 40 chains radius should be avoided, and is not good work. At least the length of a train, say 700 ft., should be secured on the straight line between reverse curves where possible.

I have enumerated shortly the main elements in the road which make for reduction of impact, and, consequently smooth running, for the purpose of showing that it is recognised that no small part of the question lies in the design and up-keep of the road.

In Appendix 4 of the Report of the Committee appointed by the Board of Trade to inquire into the vibration produced by the working of the traffic on the Central London Railway, on p. 10 occurs the following, as the result of a mathematical investigation of the

wheels and rails in respect of the action of the road and the irregularities of the surface in contact :—

"If, however, the unstrained rail has an uneven surface, or if there is want of uniformity in its supports, the stiffer the rail the smaller will be the amplitudes of the vibrations in the ground and the greater their frequencies."

In ordinary language, at high speeds the heavier the rail the smoother will be the running with a given up-keep, a principle which is working out, at any rate in this country with the chair-road, at a weight of rail of 90 lb. to 100 lb. per yard.

EFFECT OF LOCOMOTIVE DESIGN.

But beyond the question of the permanent-way is that of the design of the locomotive to run upon it, which cannot be quite separated from the former question.

All who are connected with railways know only too well that some types of locomotives, when driven at high speed, oscillate laterally and vertically to a dangerous extent even on a good road, and that the only way to obviate this is to reduce the speed.

Locomotives having four wheels coupled in front and a bogie under the footplate—4.4 American notation —are of a specially undesirable class to be run at high speed. In proof of this may be cited the Doublebois accident on the Cornwall railway on May 13th, 1895, in which two such locomotives of a fast passenger-train left a practically new Bull-headed road having easy curves, due to the type of locomotive in use.

Engines with single drivers and only one axle in front with one behind are likewise unsatisfactory, and plunge considerably at high speeds even on good roads, and there can be no doubt that the introduction of the leading bogie, giving a longer wheel-base, is the greatest improvement in this respect which has yet been carried out, and, with the increasing weight on the driving-wheels, is, in my opinion, necessary to secure steadier running and easy passage on curves; drivers have much greater confidence in such engines.

Of late, owing to the increased loads and the consequent desire to obtain greater adhesion and tractive force by additional coupling or weighting of the coupled wheels, the "pony" radial axle has come in, but it yet remains to be found whether for fast running the pony axle has the advantages of the bogie. I think not, and the bogie-wheels are undoubtedly safer at diamond crossings in curved lines.

Personally, I think the equalisation of weights by the bogie over the four points is by far the best, and reduces impact, and is so important that, even to save a few feet in length of engine framing, should not be given up.

The introduction of levers to equalise the weight on the single leading-axle with that on the front driver has much to recommend it, although, in my opinion, it cannot so satisfactorily equate the varying weights as the ordinary four-wheel bogie. This latitude given to the driving-wheel is not theoretically desirable, the object of all steadying arrangements being to ensure that the front end of the engine shall creep and not jump, and so to prepare the way for the [illegible] axles to operate at their full efficiency.

The steadier the driving-wheels are kept the greater will be the efficiency and the less, consequently, will be the wear and tear of the road. This principle ought to underlie all locomotive building, and for this reason, I think, the provision for steadying a locomotive should be separate entirely from that for driving.

For the same reason, the more the driving-wheels are equalised as between themselves the greater will be the adhesion and tractive force. The extent to which this is carried in America is shown in Mr. Cowan's paper on "American Locomotive Practice," read at the Institution last session.

What maintenance engineers on railways want are creeping machines and not hopping machines, and these will cost locomotive engineers less to maintain.

One advantage of the four-wheel coupled engine over the single, at high speed, is the fact that the counter balancing can be spread over four wheels in place of two. No doubt this is the principal reason that it is so difficult to build a single-driving-axle locomotive, even with a bogie in front, to run smoothly.

Several companies in Britain have tried compound locomotives with three and four cylinders, and the Great Western are awaiting delivery of a French compound, having four coupled wheels with leading-bogie and trailing-axle, from the makers of those used by the Northern of France Company. I have great hopes that the running of this engine with its four cylinders, long wheel-base, and the weight concentrated more towards the middle, will affect a further equalisation of the counterbalancing, and so conduce to smooth running.

It may be remarked that the running behind compound engines in other countries is not free from oscillation, but from many inspections I am inclined to attribute this to shortcomings in the road and not to the build of the engine.

Recent practice has been in the direction of raising the centre of gravity of the locomotive, but, although locomotives with a high centre of gravity are, theoretically, first-class machines if running on a perfect road, I would suggest that this practice has its limit, and that that limit is now reached with our present conditions, for the reason that any imperfection in the alignment of the road has a correspondingly increased effect in developing swaying or side motion in the engine at high speed, which, when developed, is more intense and more lasting than with lower-built locomotives. It may be gathered from the foregoing that a practical disadvantage to [illegible] such engines having to run through [illegible] where the full [illegible] the speed at which the train is running cannot be attained.

APPRENTICESHIP IN ENGINEERING TRAINING.

IN the Machinery Section of the Conference a paper on "Apprenticeship in Engineering Training" was given by Professor John Dewar

Cormack, B.Sc., Assoc.M.Inst.C.E. The paper was concerned with the training of youths who are destined to be employers, manufacturers, or consulting engineers, designers, heads of departments, technical managers, and men in responsible positions. The following is an abstract :—

Until the beginning of the last century, entrance into the trades and the professions could only be obtained by means of an apprenticeship extending over seven years, during which the apprentice was bound to serve a master, who, on his part, undertook to keep the apprentice, and to teach him his work. The system, as it then was, led to many abuses, and the Act of 1814 was designed to counteract these. It opened wide the doors to all except a few professions, and no restriction was placed either on the manner in which a youth learned his future occupation, or the duration of his training. At that time engineering, except in a few branches, was just emerging from its position among the crafts. The removal of the restrictions to entrance may have been harmful in some ways, but at all events it allowed free entrance to many men who, although trained for other pursuits, became pioneers in different branches of engineering.

Although the restrictions were removed, there still remained the idea that the proper way to become an engineer was to spend a period of five years or seven years in the workshop or office. Probably, then, in the existing state of what we are now proud to call the profession, this was desirable, but now, after a century which has seen vast developments in engineering practice, and during which, with ever-increasing rapidity, scientific discovery is turned immediately to practical utility, it seems reasonable that some more generally recognised system of apprenticeship should be devised or recommended to suit the new conditions.

The Institution has for many years devoted most careful attention to the conditions of training which should be fulfilled by those coming under its purview. The "regular training" prescribed by its by-laws is defined by the Council's rules to involve a *minimum* period of three years' pupilage or training as an assistant where the standard of education is simply that required for admission as a student ; and such minimum period of practical training may be reduced to two years where a recognised college course of study is taken. In each case the practical training must comprise both experience in the office and in or upon the works.

The Institution clearly contemplates a scientific and a practical training for all, and, taking this as a matter of common agreement, the questions to be discussed are :—

1. How should the knowledge and experience in each be acquired ?

2. Is there any arrangement suitable for all branches of engineering, and if not what modifications are required for the different branches ?

3. Over what period of time should the complete training extend ; and what is the best arrangement and division of the time ?

Let us look for a moment at the raw material and the finished product, leaving out of account the genius who may achieve eminence in engineering without special training. The raw material is a youth of seventeen or eighteen, fresh from school, educated, perhaps, to a standard below that which might be desired or expected, and supposed to be endowed with commonsense, natural aptitude for the profession, and sufficient physical strength ; and the finished product is a blend of scientific and techincal knowledge, practical experience, and business method. Our colleges should supply the first two requirements, but I venture to submit that the last two can only properly be acquired in the workshops and offices, and that no training can be considered efficient that does not include a considerable period of practical apprenticeship.

If it is considered desirable that the training of all engineers should include experience in suitable workshops and factories, specialisation being confined more or less to the drawing-office, the question under discussion is limited to the consideration of the time required, and the best division of that time between the college and the workshop. The duration of training depends to some extent upon the arrangement of the course ; but, probably, it may be safely said that to produce the ideal young engineer the training should extend over five or six years, which might be about equally divided between the college and the workshop.

Is there any one system that is the most desirable ? I leave it to discussion chiefly by engineers in practice, as I feel certain that the colleges are anxious to have a solution of this problem, and to adapt their courses to any scheme or schemes that may be thought desirable.

In this country at the present time the systems in operation might be classed as :—

(*a*) 1 and 2, "separate" systems.
(*b*) 3 and 4, "combined" systems.
(*c*) 5 and 6, "compromises."

THE VARIOUS SYSTEMS CRITICISED.

1. *Workshop only.*—This is a survival of the old traditions. It demands physical exertion during the day and mental strain at night if theory is to be acquired. Many eminent men in the past have undergone the strain and emerged successfully ; but in the future the ever-increasing demand upon the engineer will render it unpractical, and almost impossible.

Many clever youths enter the shops on this system with limited opportunities, but with great ability, and provision should be made for them in any scheme of training.

2. *College only.*—Under exceptional circumstances, such as obtain in the United States, this may be expedient, but it is undesirable.

3. *Works before College.*—A youth entering college after, say, three years in the factory and office, is in many respects a good type of student. He has gone through the shops at the receptive and imitative age ; he has ascertained whether engineering is still

to his liking, and comes to college with a knowledge of processes, materials, and machinery. He has some idea of what he wants to know and what branch he wishes to enter; but has often wrong theories which are difficult to uproot. Teachers prefer this type, provided he has continued his studies during his apprenticeship; but this is not always nor even generally the case. The youth may have forgotten much of his school training, and, what is worse, he may have forgotten how to study. If he has studied, it is under trying conditions, when he is physically tired, and he may wish to confine his studies to the more interesting technical subjects, the science underlying them being more or less neglected, and, in consequence, his progress is less rapid. He comes to college probably disinclined to begin again and gain the scientific knowledge which ought to precede all its applications.

4. *College before Works.*—A youth fresh from school and sufficiently educated is likely to make good progress in his scientific studies. In the technical work he is handicapped by his want of knowledge of manufacturing processes and the operation of machines, and is unable to associate his theoretical studies with practical examples of which he has had experience. Laboratories help to some extent to reduce the handicap. If this was to be the standard training there would be a greater plea for college workshops, which would supply some little practical experience, but which could not supplant, even partially, the workshop training under commercial conditions. Some may urge that this system produces a man disinclined to undergo what he calls the "drudgery" of the workshops, but others will be as ready to admit that the proper type of youth acquires his practical experience at a much more rapid rate after he has undergone a college training, and has no such disinclination.

This system may be preferred by employers as distinguished from system 2, which may be preferred by teachers.

Other systems are in vogue, either by accident or design, whose object is to avoid the disadvantage connected with "separate" and "combined" systems or to minimise the required period of training.

5. *Intermittent systems.*—These include the Works-College-Works and College-Works-College systems. Many arguments can be advanced by the advocates of each. The first arrangement has to a lesser extent the disadvantages attached to system 3, and the latter system those of system 4. Both waste time in so far as the usual college terms extend over only nine months of the year, and the remaining three months may be wasted, as few engineers care to take youths for three months in the year. But, probably, on the whole, this system is preferable to 3 or 4.

In the College-Works-College system the youth fresh from school has an opportunity of acquiring a foundation of science on which to rest his works experience; but if study is not continued his knowledge may evaporate in the works, and at the end of his training he is out of touch with his employers.

6. *Sandwich system.*—This system goes one step further. During a period of, say, five years' training, for four years, six months of each year are spent in the factory or office and six months in the workshops, and the additional year is spent in the workshops or office. It lessens the discontinuity between the two parts of the training and effects a saving of time, inasmuch as the college long vacations are utilised. An objection which may be put forward is that the youth is always "on the move." He has no time to settle down to either the workshops or college work, and he may have difficulty and extra expense in arranging for lodgings. It must not be forgotten, however, that each part of his work forms a recreation for the other, and the student is likely to return to each with considerable keenness.

7. *Concurrent systems.*—These either give time for study in classes in connection with workshops, or offer workshop training in connection with college. Both systems have already been alluded to.

The objections to 1 and 2 may be applied here. Time taken off the workshops for study gives less time for the practical experience, and this is not acquired under strictly commercial conditions. Except in the very largest works it is impossible to provide the requisite standard of teachers, and if it is necessary that the youths should breathe the atmosphere of the shops, probably it is perhaps equally necessary for him to breathe the atmosphere of the college.

The list may not comprise all the systems in vogue, and the arguments for and against them are merely indicated, but it serves to emphasise the diversity of the ways in which a youth may enter engineering.

Is it not possible, at least to some extent, to standardise the training?

HIGH-SPEED ELECTRIC TRACTION ON RAILWAYS.

A PAPER on this subject was read at the Engineering Conference by Mr. J. W. Jacomb-Hood, M.Inst.C.E. The following is an abstract:—

The subject divides itself conveniently as follows: (a) generation; (b) consumption; and (c) transmission, distribution, and collection of current.

GENERATION OF CURRENT.

Of all the vital questions connected with power-stations, perhaps none is more important, although diverse opinions have been expressed, than the economical limits of size of steam or gas-generating sets. In this country one or other would be, in nearly all cases, the only alternative. The possible positions of generating stations relative to the railway will frequently decide units, but assuming that the power capacity of stations will be governed by the limit of economy in generation, it is important that the subject of the most desirable maximum size of steam or gas sets for power-stations should be well ventilated. After taking account of the

increased cost and losses in extended transmission-lines, reason would seem to dictate that the power-stations should be as widely separated and as few in number as possible, to ensure steadier load and a better load-factor.

Power-station practice is rapidly becoming standardised in detail, so that it can be foreseen with some confidence that moderate-speed engines, directly coupled to alternators generating in single or multiphase form at tensions as high as circumstances allow, will be used. As economy in every detail will have to be studied, it may be that gas-engines in connection with a producer-plant will prove the ultimate solution.

CONSUMPTION OF CURRENT.

Without invading the territory of the electrical engineer, it is possible to bring forward one point of practical importance in connection with motor design. The practice of to-day seems to be almost universally in favour of a direct-current series-wound motor, with automatic field-regulation, which will run economically at any speed up to a maximum. On the other hand, there is the alternative, with some economical advantages to recommend it, of a system that involves the use of smaller high-tension currents, used in alternating single or multiphase motors, that are limited to one or, at most, two economical speeds. Opinions differ widely as to the class of traffic for which invariable speeds are suited; and it must be confessed that it is extremely difficult to foresee the effect that invariable speed would have upon the conduct of general railway business. It is, however, tolerably clear that for any class of business variable speed is to be preferred.

Such points as the position and individual power of motors are all interesting, but inasmuch as motors arranged on a multiple-unit system to ensure minimum train weight, and maximum weight available for adhesion, will almost certainly be employed for high-speed railway service, whilst electric locomotives of high power-capacity for freight, shunting, and other general business, will also be required in the railway business of the future, time need not be employed in discussing them.

TRANSMISSION, DISTRIBUTION, AND COLLECTION OF CURRENT.

The principles of generation and consumption of current being determined, systems of transmission, distribution, and collection must to a large extent follow. But it is here that the practical difficulties present themselves most formidably to the railway man. With all the complications due to dense traffic within a very limited construction-gauge, and with the imperative need of safeguarding life and limb, it is difficult to see how any system of distribution is to be carried out without serious objection. This part of the problem needs the fullest consideration that the conference can give.

Transmission, perhaps, has the fewest difficulties. In view of the urgent need for economy in first cost, it is to be hoped that we may in time accept the continental methods of using bare overhead transmission-lines for carrying current at high voltage, rather than incur the heavier expense of cables.

So far as existing practice is a guide, a system of distribution to feed a third conductor-rail will appear to meet the needs of the case. There are in existence cases of railways where large currents are being collected from a third rail at speeds approaching 50 miles an hour, and experiments in this direction indicate that still larger currents than these can be taken at speeds up to 70 miles an hour. But the existence of a third rail at all, in any position, introduces troubles in the upkeep of the road and in other directions that are better avoided if possible. An overhead-conductor system would probably be less unwelcome to the maintenance engineeer, and from some points of view it has advantages over any ground collecting system. But here, again, if the system is one of high-tension triphase current, the duplication of conductors presents another difficulty.

It will be interestng to watch the developments in the United States of the experiments about to be made with single-phase alternating currents, involving only one overhead conductor. The difficulties in the way of collecting a comparatively heavy current from an overhead equipment appear to have been to some extent overcome on one of the North Italian railways, and developments in this direction may be of assistance.

Systems that have been advocated of collection from the primary conductor for use in a motor-generator on a locomotive seem attractive, and inasmuch as they would do away with substation difficulties and expenditure, the problem may thus be solved.

Inasmuch as pure accumulator systems, although they may be useful and economical for light branch-services, are not thought to have any promise for heavy general railway work, no further mention of them seems called for.

In these notes the author has attempted to put forward in the briefest possible manner some of the main points that demand the consideration of all who are interested in this important subject.

PERCUSSIVE COAL-CUTTERS.

THE following is an abstract of a paper by Sir Thomas Wrightson, Bart, M.P., M.Inst.C.E., and Mr. John Morison, M.Inst.C.E., included in the section of the Engineering Conference devoted to "Mining and Metallurgy":—

It has been a reproach of long standing to British engineers that coal-cutting by machinery has not been applied in this country so successfully, nor to such an extent, as in the United States of America and in Canada.

Mr. Ritchie, when Home Secretary, gave very emphatic expression to this reproach in the House of

Commons last year, on the occasion of the discussion of a Bill relating to labour in mines, when he said: "One great complaint which I am inclined to make about our mineowners is that they are not availing themselves of coal-cutting machinery to anything like the extent they ought to do—to anything like the extent to which it is done in the United States, where the quantity of coal cut by machinery of late years has arisen enormously, while it is almost at a standstill in this country."

Careful examination of the position in respect of coal-cutting in this country and in America leads, in the authors' opinion, to the following conclusions:—

(*a*) That in America machine coal-cutting has been successful both in respect of the relative cost of hand to machine-work, and in respect of the universal adoption of machines.

(*b*) That in this country, in both respects, up to the present time, almost the opposite experience has been the result of the adoption of machinery, it being found that the generally expressed opinion is that the economy, except in special cases, is doubtful, whilst the use of machines is extending very slowly, and their general adaptability is very far from being recognised.

Looking more closely into the causes of this apparently anomalous position, it is the authors' opinion that they may be traced to the following:—

1. To the more favourable general conditions of the American coal-seams in respect of thickness, depth, and inclination.

2. To the softer nature of the American seams.

3. To the fact of the two conditions above stated lending themselves to the easy application of machinery of the type of the American percussive or punching machine, and other machines which do not require a longwall-face or any other special conditions in working, but which are adapted to the ordinary system of working prevailing in a mine.

The conditions in this country differ in respect of the hardness of the coal and the thickness generally of the seams; but the prevailing feature which, in the authors' opinion, has been the cause of the failure of percussive machines in this country and their success in America, is the harder nature of the coal-seams here.

Percussive machines of the American type have been over and over again tried in this country and abandoned, and, at the present time, if any are working successfully it is not generally known, and is nowhere, to the authors' knowledge, recorded. In America, on the contrary, the prevailing machine, and the machine which at the present time is mining most coal, is the percussive machine. Thousands of these are in use daily, and apparently they are worked without any great difficulty in their manipulation.

CONDITIONS NECESSARY TO SUCCESS.

It appears to the authors that, in order to obtain success in cutting hard coals with a percussive-machine, there are two essential conditions necessary in order to obtain the success which has been obtained in America. These are:—

1. A heavier blow from the machine, in order to obtain more rapid cutting.

2. Mechanical arrangements for taking the recoil off the operator.

The latter has been attempted in several machines, chiefly of German manufacture, by mounting an ordinary rock-drill upon a column, which entirely removes the shock or recoil from the operator. In this arrangement the cutting-tool is swept round with the column as a centre, and the point of the tool acting upon the face, is fed up as the cut is effected, to a larger radius, a longer tool being put in when the feed-screw of the machine is exhausted. This form of percussive coal-cutter has only recently been introduced into this country, and appears to have attained a considerable measure of success.

The authors, after very prolonged experiments, have produced a machine (exhibited) in which their aim has been:—

1. To take the recoil of the blows off the operator.

2. To increase the force of the blows on the coal-face; to strike such a number of blows as will, in the hardest coal, effect an economical speed of cutting; and to mount the machine so that it can readily be removed from one part of the workings to another.

CONCLUSIONS.

The authors take the view that American success is due to the punching or percussive machine, and to its adaptability to the prevailing system of mining. That, given the possibility of cutting out the narrow work in a mine rapidly and economically, the system of roads formed in the solid, as against those formed in the goaf, or longwall-roads, presents in many instances considerable economical advantages and that coal-cutting by machines adapted to these conditions is a more advantageous application than longwall machines, where the process of "kirving" or undercutting is a smaller proportion of the total labour costs than in the board-and-pillar system, whilst the latter system presents, apart from the cost of forming the first workings, many advantageous economical conditions.

They are also of opinion that the portability of the percussive machine renders it applicable to a more general extent than the heavier longwall machines, which involve requirements such as freedom from faults, good roofs, and uninterrupted [illegible] coal, conditions which do not exist to such an extent as to render the application of the heavier longwall machines in all cases economical.

There is the further consideration that whilst in the percussive machine wear and tear is practically nil, and breakdown remote, in the longwall machines wear and tear is very heavy, and stoppages continual.

It is therefore the authors' opinion that as to America so it will be here, the percussive machine will be the one which will ultimately solve the problem of mechanical coal-cutting.

ELECTRIC *versus* HYDRAULIC APPLIANCES IN DOCKS.

IN the course of a short paper contributed to the Engineering Conference, Mr. Walter Pitt, M. Inst. C.E., dealt with "The Modern Equipment of Docks, with special reference to Hydraulic and Electric Appliances." He argued that the electric transmission of power can do everything that the hydraulic transmission of power can, and a great deal more besides, and it does it at a cheaper rate. His argument, summarised, was as follows :—

1. The first cost of an electric installation is not more than that of a hydraulic plant.
2. The cost of upkeep is no more.
3. The electric machines are more efficient and take less power for the same work done.
4. The power is less costly to generate.
5. The transmission losses are less.
6. The general adaptability is incomparably greater.

THE DECAY OF METALS.

AT an ordinary meeting of the session of the Institution of Civil Engineers, Messrs. S. T. Milton and W. S. Larke contributed a paper on the above subject. The authors remarked that the durability of metals under the conditions in which they are actually used is of great importance, and must always receive as careful consideration from engineers as questions of strength or cheapness. Copper, brass, gun-metal, and other alloys are chosen for use on account of their durability ; but even these metals are sometimes found to corrode or decay under seemingly obscure conditions. It was to cases of such decay, and to a discussion on their probable causes, that the paper was devoted.

The following examples of the decay referred to were adduced :—

1. The pitting of the tubes of marine surface-condensers.
2. The decay of brass or yellow-metal bolts in composite vessels, and in the under-water fittings of iron and steel ships.
3. The decay of the brazing-metal in copper steam-pipes.
4. The deterioration, as distinguished from oxidation, of cast iron used for parts of marine engines, and also for other appliances which were in frequent or continuous contact with sea-water.
5. The decay of some propellers made of the patent bronzes when fitted to copper-bottomed vessels.

In the case of condenser-tubes it was apparent that some of the metal became eaten away into holes, while in the other cases mentioned the metal appeared to retain its original form. The authors termed the former action "corrosion," and the latter "decay."

Chemical analysis of the decayed portions showed that a change had occurred in the composition of the metal, but did not explain why its strength and properties were so completely modified. It showed that in copper-zinc alloys the process had been mainly one of dezinckification, or loss of zinc, while in cast iron, part of the iron, and possibly also of the manganese, had disappeared, the whole of the graphitic carbon remaining.

IN COPPER ZINC ALLOYS.

Although the decay of copper-zinc alloys had been known for many years, the first published research into its cause appears to have been made by Professor Arnold, who in 1898, investigated the case of the failure of a marine boiler steam-pipe. He pointed out that the brazing-metal of the pipe, when microscopically examined, was seen to possess a duplex structure, similar to that of Muntz metal, both constituents being definite chemical compounds of copper and zinc, but one richer in copper than the other ; and he attributed the decay to local galvanic action set up between these constituents, whereby in the first stage, the one less rich in copper becomes dezinckified, and subsequently that richer in copper also lost its zinc, the whole then becoming a spongy mass of copper.

Microscopic study showed that the Muntz metal tube-plates, rods, etc., illustrated in the paper had been subject to similar decay to that pointed out by Professor Arnold, and also that in the decay of cast iron the complexity of structure doubtless led to the same result, the decay in this case advancing along the lines of the graphite plates and leaving the phosphide eutectic portions till the last.

IN CONDENSER TUBES.

This explanation of local galvanic action, however, did not account for the corrosion and decay of condenser-tubes which were made of an alloy not having a duplex structure ; nor did it explain why cast iron in some cases did not decay, even although its composition and structure were the same as in other cases where decay took place.

Condenser-tubes were usually made of an alloy consisting of, nominally, 70 per cent. copper and 30 per cent. zinc. The Admiralty specification was, not less than 70 per cent. copper and 1 per cent. tin, the remainder being of zinc ; while one of the large mail steamship companies, as the result of considerable experience, had the tubes made of 78 per cent. copper, 21 per cent. zinc, and 1 per cent. tin.

These were nominal compositions, for commercial copper and zinc were rarely pure. If the impurities became uniformly diffused through the mass of the alloy it would still be homogeneous, but if they had a tendency to segregate, as it was well known some elements did in steel, there would still be such want

of uniformity as might set up local galvanic action and lead to local pitting or corrosion. Segregation was not only possible during the solidification of the alloy in the original casting, but might also occur while the metal was at a high temperature during the operation of annealing, which was several times repeated in the course of the drawing process.

If segregation occurred during solidification only, the drawing process would cause the impure portions to be much elongated in the direction of the tube's length, and the resulting corrosion would be seamy; whereas if it occurred also to a marked degree during annealing, the corrosion would affect more rounded areas. Examination of the insides of condenser-tubes revealed cases of deep corrosion of both kinds; but in addition it was seen that the general surface of the inside of the tubes had become partially dezinckified to an extent sufficient to cause it to crack when the tube is flattened.

EXPERIMENTS.

In order to determine whether the various impurities which are commonly present in copper-zinc alloys do tend to segregate or diffuse during annealing, some experiments, detailed in an appendix, were made. These experiments incidentally threw some light upon the changes of structure which Muntz metal, and also the 70-30 copper-zinc alloy underwent, due to changes of heat treatment.

It was pointed out that considerable protection was given to copper-zinc alloys, when exposed to the action of sea-water, by the practice, adopted by the Admiralty, of requiring the addition of at least 1 per cent. of tin to all such alloys.

CONCLUSIONS.

The conclusions arrived at were :—

1. Iron.—Beyond the very small portion which doubtless existed in a state of solid solution in the brass, iron occurred in combination with zinc as small isolated particles, which were neither diffusable nor liable to segregation. These particles were probably a zinc-iron alloy.

2. Lead.—A small portion of this metal would also exist in brass in a state of solid solution; but beyond the saturation point, lead did not diffuse into brass. A small proportion, however, in solid solution materially increased the liability to corrosion.

3. Tin.—This metal could exist in small proportions in solid solution in brass and in Muntz metal. In the latter it probably entered into both micro-constituents; but when present it certainly occurred in the one which was richest in zinc, as was shown by the protective effect it gave to this constituent against corrosion in sea-water. In larger quantities, tin would also diffuse into brass, the extent of the diffusion depending upon the temperature to which it was raised.

4. Zinc.—Zinc alloyed with copper in all proportions, and if it was not uniformly distributed through the metal, it tended to become so by prolonged heating.

Some experiments, detailed in a second appendix, were also made to determine the galvanic action between copper, iron, brass, Muntz metal, etc., when in contact with sea-water; and other experiments showed that weakly applied currents, when long continued, had a decided corrosive action upon copper and its alloys when immersed in sea-water, the amount of corrosion—with the same current—being greatest in those containing the highest proportion of copper.

With a current of 0·001 ampere acting on an immersed area of forty square centimetres in the case of Muntz metal, the wasting produced was confined to the dezinckification of the constituent poorest in copper; but the same current, acting upon sixty square centimetres of ordinary brass condenser-tubes, gave rise to a fairly uniform corrosion, both the copper and the zinc of the alloy being dissolved.

SUMMARY OF RESULTS.

Summarising the results of the investigation it would appear that—

1. Decay was more frequent in metals which had a duplex or more complex structure than in those which were comparatively homogeneous.

2. Decay was due to a slower or less energetic action than that causing corrosion, and, moreover, it required an action which removed part only of the constituents of the metal, whereas corrosion removed all the material attacked.

3. Both decay and corrosion might result from chemical action alone, or from chemical and electrolytic action combined.

4. Pitting, or intense local corrosion, was probably often due to local segregation of impurities of the metal; but it might also in some cases be due to local irregularities of surface or structure producing local irregularities in the distribution of galvanic currents.

5. In the case of brass exposed to sea-water, tin was distinctly preservative, while lead and iron were both injurious, rendering the brass more readily corrodible. The percentage of the latter elements should, therefore, be kept as low as possible in the case of all metal intended for purposes where contact with sea-water was inevitable.

6. With a view to obtain a minimum of corrosion, the internal surfaces of condenser-tubes should be as smooth and uniform as possible; and in order to ensure this, the cast pipe from which they were drawn should be smoothly bored inside, either before the drawing was commenced, or in an early stage of the process, as was done in the manufacture of [illegible] boiler-tubes.

7. The experiments with an applied current show that electrolytic action alone, even where exceedingly minute currents were in question, might result in very severe corrosion or decay. Every effort, therefore, should be made to prevent such action by careful insulation of all electric cables. Where galvanic action was inevitable through the proximity of different metals exposed to the same electrolyte, the corrosion resulting should be neutralised by the application of zinc plates in the circuit, so arranged that they would be negative to both of the other metals.

NEW CATALOGUES.

Mather and Platt, Ltd., Manchester.—This firm is bringing out a series of elaborate and beautifully illustrated booklets. The electrical textile and engine departments have been split up into some half dozen or more sections, which have been extensively dealt with from time to time. From the most recent that has been published, entitled "Artesian Wells and Bore Hole Pumps," we gather that quite a large business is being done by the firm in this direction. A short description is given of the methods employed, namely the flat and the round rope systems, with illustrations of the machinery and pumps. Other specialities include water filters, in various standard sizes, having capacities ranging from 6,500 to 500, 000 gallons per 24 hours—and a water softening apparatus.

The Electrical Company, Ltd., Charing Cross Road, London, W.C.—A 16-page "Fan" catalogue, containing descriptions, with half-tone illustrations and prices of the "E.C." electric fans and ventilators of many designs, including the "wall," "desk," or "ceiling," for continuous, alternating, and three-phase current motors in any voltage up to 440. At a little extra cost perfume distributors can be attached. For fans of any other capacity or description (not mentioned in this catalogue) reference is made to price list No. 2, 1903.

The Portable Building Company, Ltd., Fleetwood, Lancs.—Catalogue of 76 pages and cover illustrating and describing portable and permanent timber-framed buildings, the majority of which, we are told, have been selected from buildings actually erected and completed by this firm in various parts of the world, including chalets, residences, shooting boxes, bungalows, cottages, a "collapsible tent," portable iron buildings, studios, billiard rooms, pavilions, club houses, etc., etc., A speciality, of which we understand this firm has made a careful study, is the erection of sanatoria for the open air cure of consumption, and illustrations are given of several, as well as hospitals, etc., which have already been built in various parts of the country. The list of the patrons which appears at the end of the book includes many well-known names.

The Cruse Controllable Superheater Company, of 5, Blackfriars, Street, Manchester, have issued a 48-page booklet descriptive of their controllable superheater and dry steam generator. It is claimed that this generates superheated dry steam with the superheat under immediate control, and adjustable at will to the requirements of each case as work and circumstances may demand ; that it effects (1) a considerable economy in fuel in the generation of steam, or an equivalent increase in the evaporative capacity of the boiler ; (2) a considerable economy in steam at the engines, or an equivalent increase in power ; (3) continuous and regulated circulation of the boiler water ; (4) efficient heating of the feed water. A number of excellent diagrams, printed on art paper, are bound up with the book, which makes interesting reading.

The Nicholson Ship Log Company, Cleveland, Ohio, U.S.A.—An illustrated booklet describing the Nicholson Ship Log—a contrivance which automatically indicates the speed of a vessel, in miles or knots, per hour, on a dial, and registers the same on a counter, also on a paper record chart with the day of the week and hour of the day. The log is enclosed in a case with plate glass front and sides 31 in. high, 19 in. wide, and 9 in. deep, and can be placed in the pilot house, captain's cabin, engine room or main saloon. We are informed it is well adapted for use on steamships, sailing vessels or yachts, and is not liable to get out of order. It is claimed that with the Nicholson Log all the difficulties of the old style of log are completely overcome, inasmuch as there is nothing to affect its reliability, as the water will always have the same action in the float pipes, notwithstanding the weather or the condition of the surface of the sea, and, being practically automatic, very little attention is required except to wind the clock and change the paper record once a day.

Messrs. C. W. Burton Griffiths and Co., of Ludgate Square, Ludgate Hill, London, E.C., and 59, Finnieston Street, Glasgow, have just issued a new catalogue specially relating to engineers' small tools, and intended principally for the use of mechanics working to exact measurements. The numerous tools are very fully illustrated and described, and the catalogue should be invaluable to engineers, machine tool builders, motor manufacturers, electricians, bicycle makers, mathematical instrument makers, amateurs, and, in fact, all who require tools of precision. The first two pages show portions of the small tool department. The various tools are admirably displayed in a handsome oak frame cabinet, the drawers of which are provided with glass fronts each having a sample board covered with red plush, so that visitors can see the contents at a glance. Several cabinets are devoted to the Standard Tool Company's twist drills. The tools illustrated can be used by metal-workers, wood-workers, pattern-makers, plumbers, etc., and, owing to its completeness, the catalogue may be studied with advantage by students in technical schools. Amongst other specialities dealt with are micrometer calipers of different sizes for measuring up to 12 inches by thousandths, half-thousandths, and even ten-thousandths of an inch ; Vernier calipers, squares, hardened steel rules, dividers, surface gauges, depth gauges, levels, combination squares and sets (with hardened and unhardened heads and blades), draughtsmen's protractors and scales, and "Union" iron and wood planes. Eleven pages are devoted to various kinds of fixed caliper gauges, limit gauges, thread gauges, etc., and other sections deal with the Standard Tool Company's twist drills, reamers, milling cutters, gear cutters, etc., taps of all kinds, stocks and dies, and the Union Manufacturing Company's chucks. The whole of the chucks made by this firm have lately been remodelled. Other useful articles catalogued include lathe tool holders, expanding mandrels, ratchet drills, wrenches, breast drills, hack saws and frames, tapping attachments and die heads, "Woodruff" patent keys and cutters, surface plates, automatic belt shifters, for shifting the belt from one step to another on the cone of a countershaft without stopping the machine, the "Sterling" solid Corundum emery wheels, belt lacing and fasteners, trucks, grindstones, etc. Several pages at the end of the book are devoted to tables of useful information.

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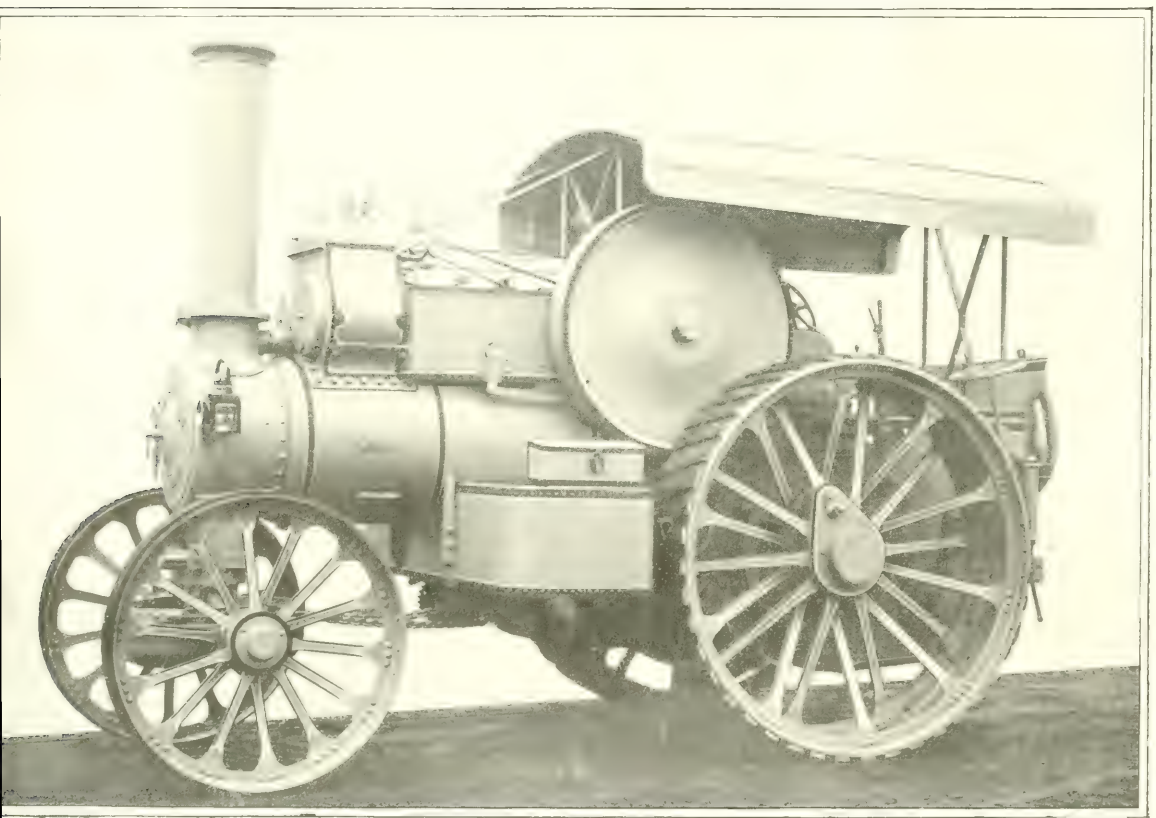

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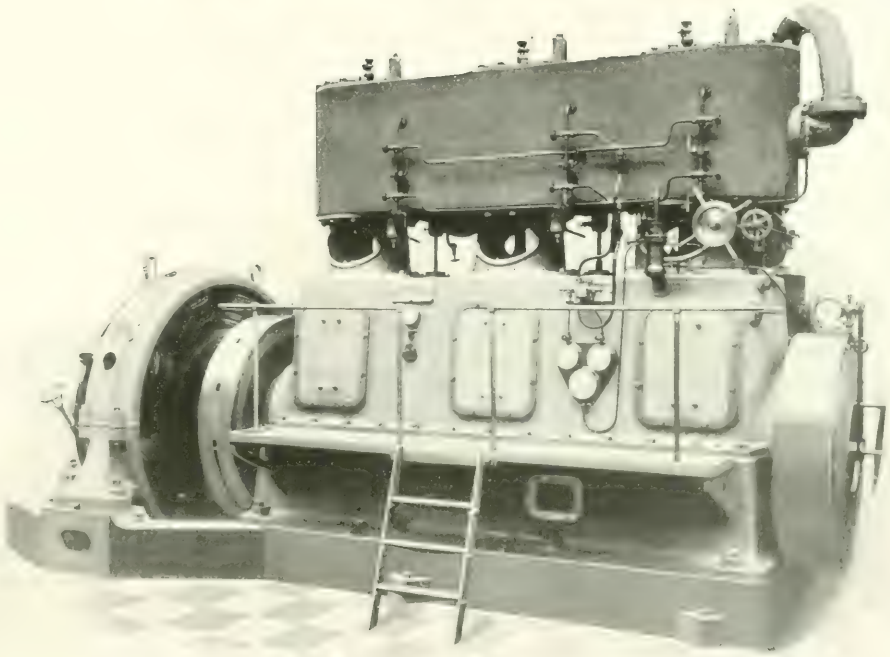

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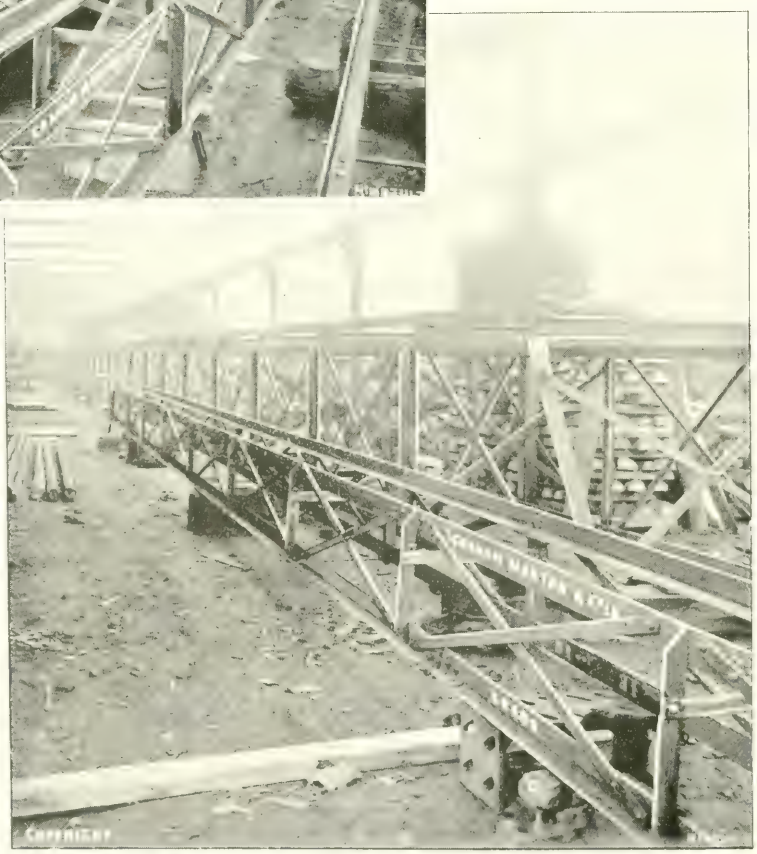

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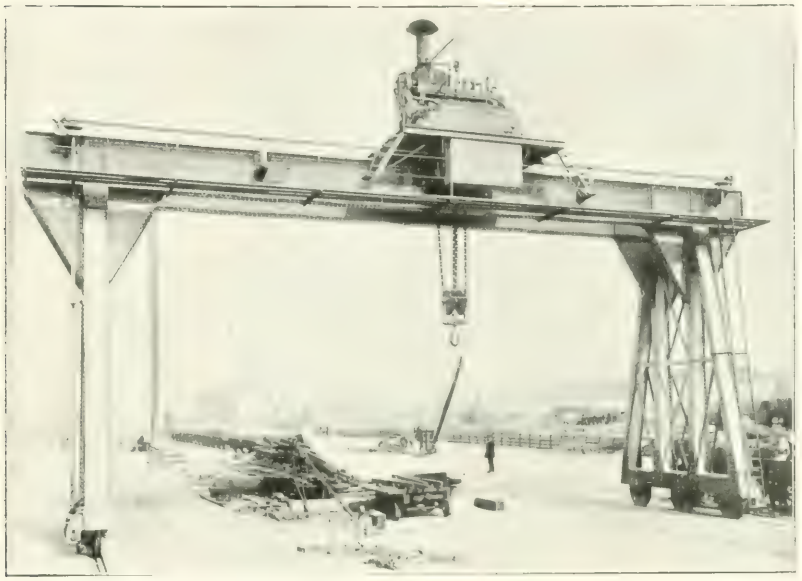

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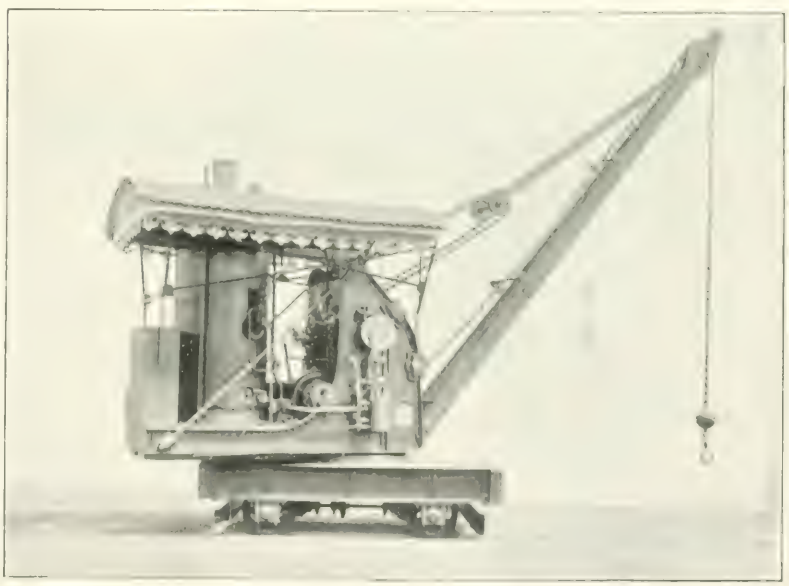

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Railway Wheels & Axles

of every Kind.

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(PITTSBURG, PA., U.S.A.)

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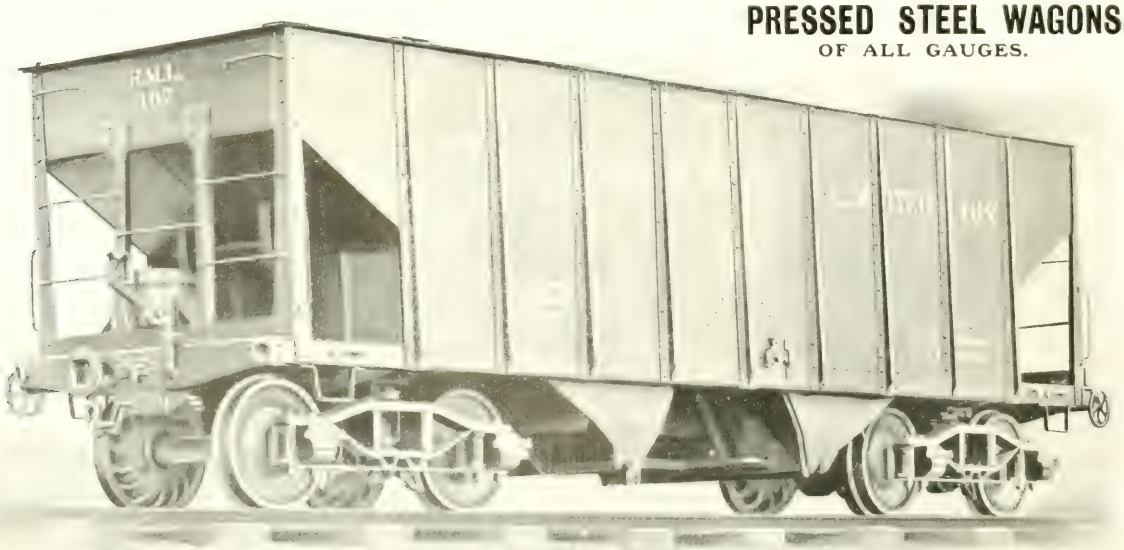
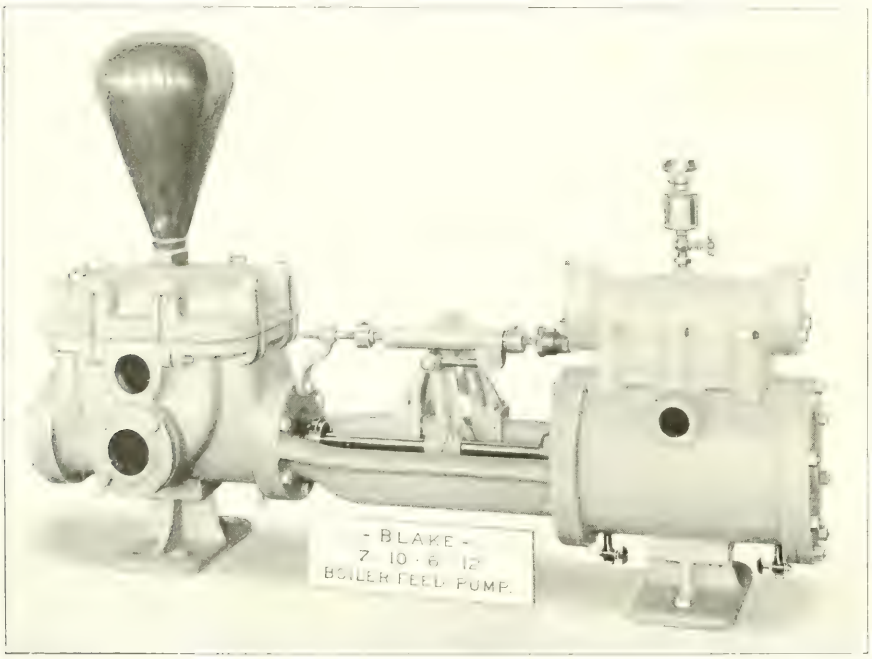


30-Ton Self-Clearing Coal Hopper Wagon, as used in South Africa.

DO YOU WANT A PUMP?

This may seem a somewhat unusual way of advertising Pumps, but if you *do* want one —no matter for what particular service—and will drop us a line, we can show you that we have a good article, and can suit you.



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CATALOGUE AND PRICES ON APPLICATION.

The . .

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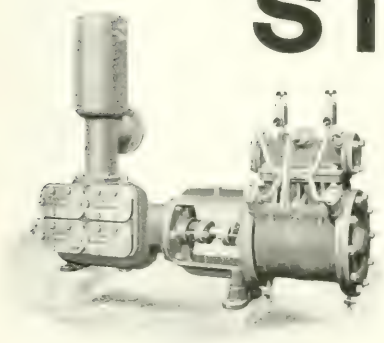
STEAM PUMPS

FOR ALL DUTIES.



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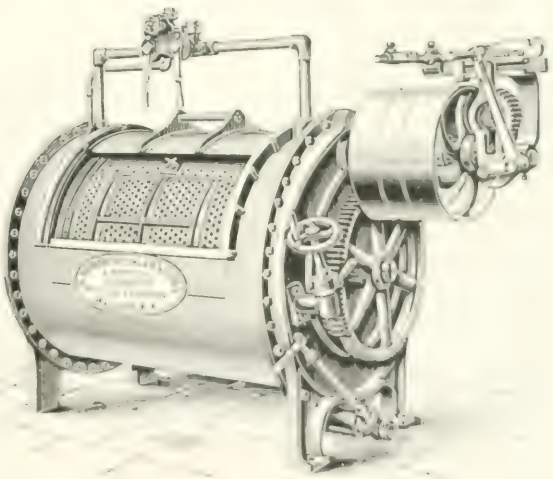
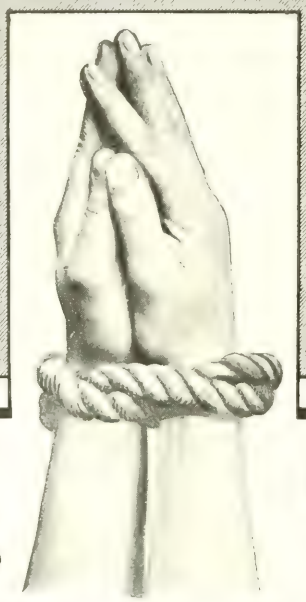


Catalogues on Application.

W. Summerscales & Sons, Ltd.,

PHŒNIX FOUNDRY, KEIGHLEY, ENGLAND.



ARE YOUR HANDS TIED?

By the opposition and prejudice of a short-sighted municipal policy in the matter of refuse disposal—a policy which involves burking the question, doing the work in the most unsatisfactory manner, and losing opportunities of saving the rates?

A visit to Darwen or to one of the destructor plants erected by us in your more immediate neighbourhood should do much to dispel fallacious notions.

The Meldrum Destructor goes to the root of the matter, effectually disposing of the refuse once and for all. Not merely eliminating the undesirable, it conserves the valuable residue, and proves at once an indefatigable scavenger and money-maker. Wideawake corporations are using the surplus heat for steam power in their electric light and tram departments.

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DESTRUCTORS

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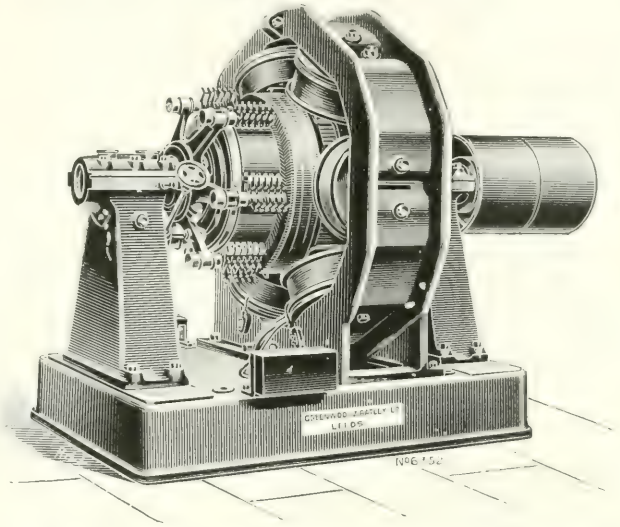

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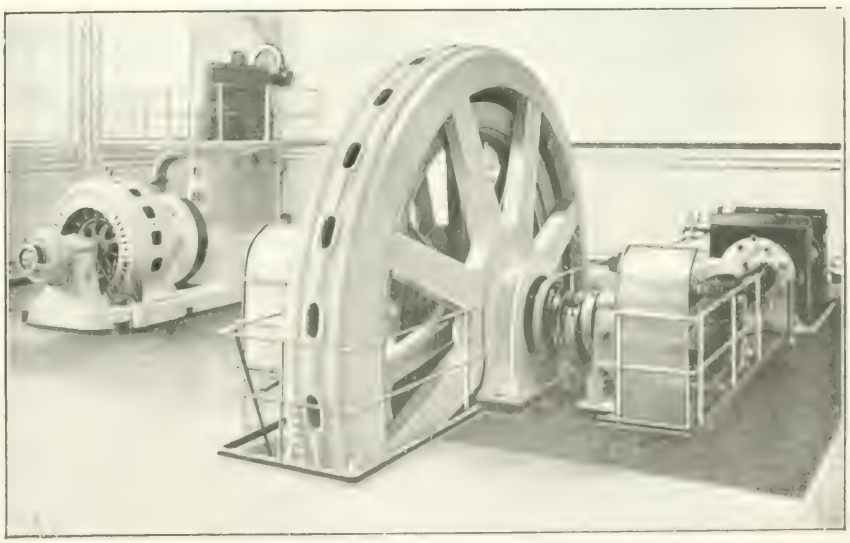

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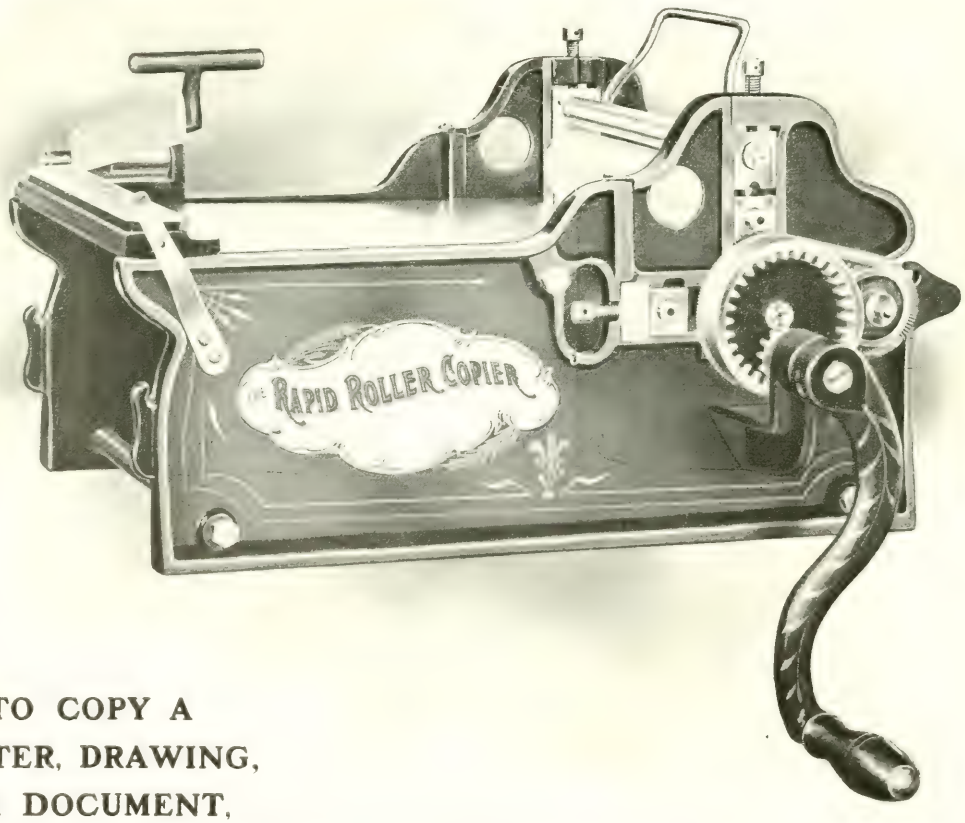

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Insert it in the Machine—turn the crank and your copy is made.

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Talks out of the top of his hat!

A man who says that an antiquated Letter File has been in use twenty-five years, and therefore cannot be bettered is "talking out of his hat."

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How the system does it and why it does it we will gladly tell you on receipt of a postcard.

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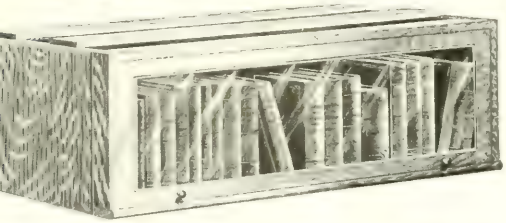
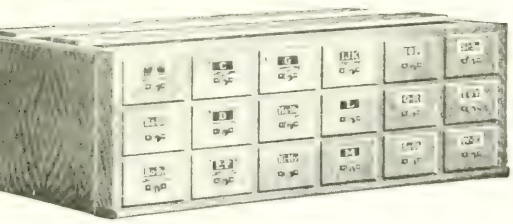
58, The City Arcades, BIRMINGHAM.
Union Buildings, St. John St., NEWCASTLE-ON-TYNE.

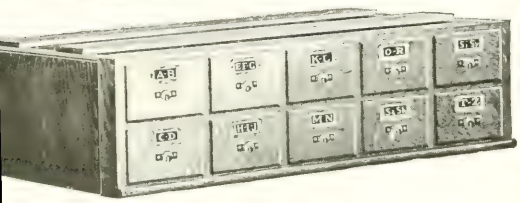
No. 17.
Top.



No. 902.
Bookcase Section.

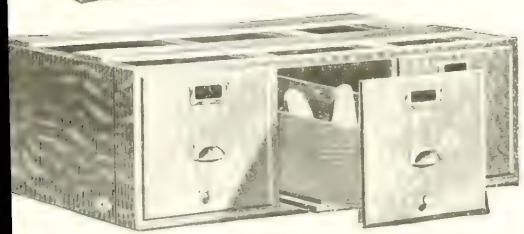


No. 53.
Card Index Section.
5 by 3 Cards.

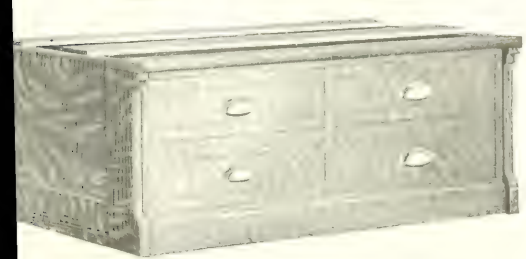


No. 64.
Card Index Section.
6 by 4 Cards.

No. 85.
Card Index Section.
8 by 5 Cards.



No. 20.
Vertical Filing Section.



No. 13.
Base Section.

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Require such a variety of sizes of cards that

ROCKWELL-WABASH
EXPANSION BUSINESS SYSTEMS

have been arranged to supply this demand by incorporating sections that contain drawers or files which will hold three sizes of cards—5 by 3, 6 by 4, or 8 by 5—so that the necessity of having special cabinets built to accommodate the various sizes is obviated.

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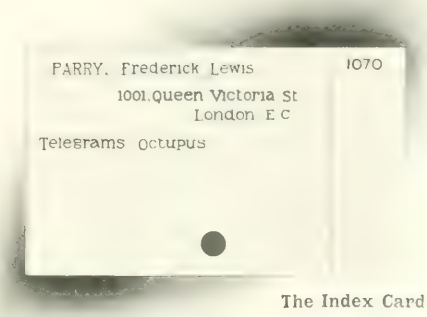
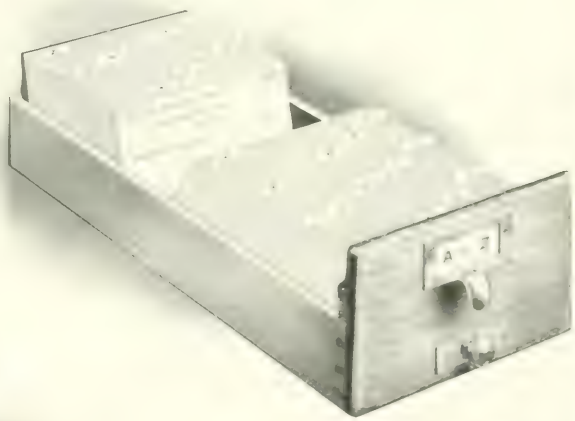
LYLE DOSSIER



The Index Card.

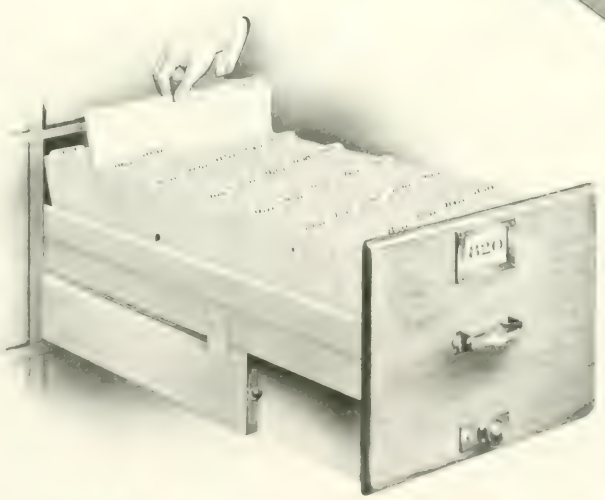
Its History.



The Card filed away in alphabetical order in Card Cabinet, forming index to Dossier.

Catalogue and full particulars—

THE LYLE Co., Ltd.,
Card Index Experts,
26, Harrison St.,
Gray's Inn Rd.,
LONDON.

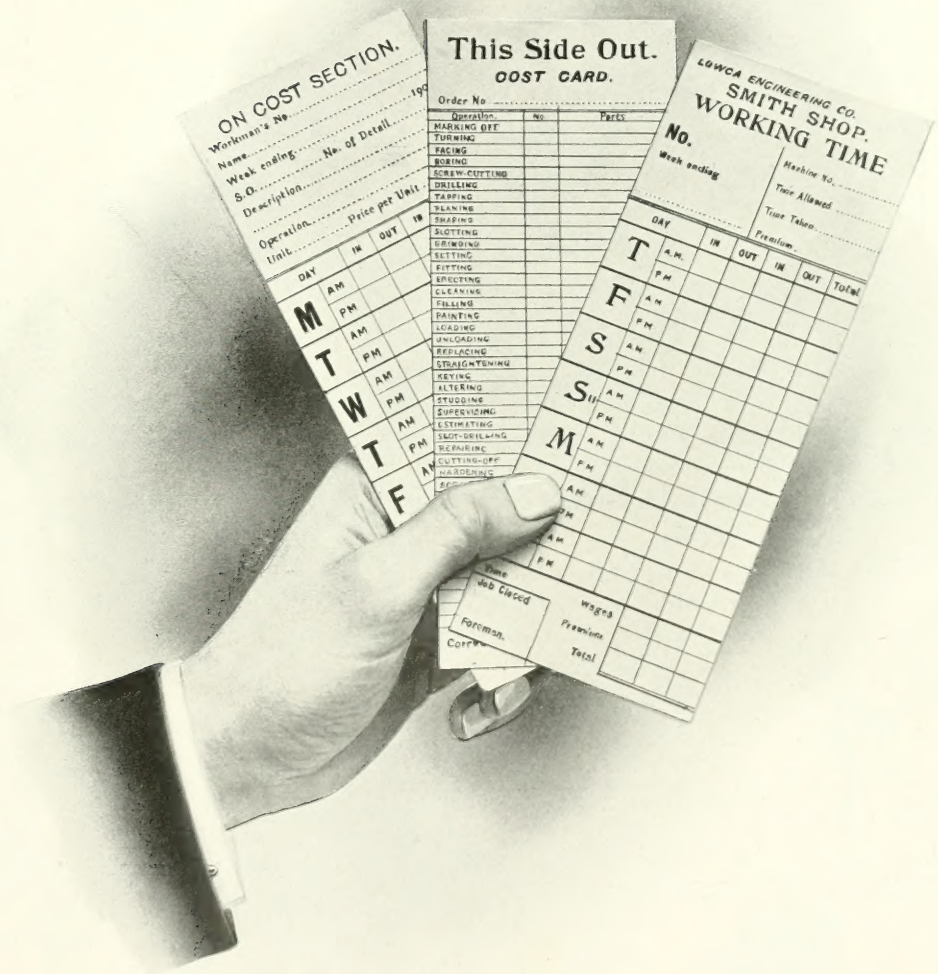


The Drawer, showing Dossier containing correspondence.

Branch Office:
94, Market Street.
MANCHESTER.

FILE

COST=KEEPING.



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